TEAM
Technology, Engineering & Management Course
Department of Chemical Engineering

Queen's University

THE CONTROL OF MAJOR ACCIDENT HAZARDS IN CANADA

Canadian Society for Chemical Engineering

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Canada's Chemical Producers

ABOUT TEAM

This report was produced under Technology, Engineering and Management (TEAM), a multidisciplinary project course offered by the Department of Chemical Engineering at Queen's University that links fourth-year undergraduate students (arts, science, engineering, and commerce) and upper year law students with industries seeking additional consulting resources. Started in 1995, TEAM provides participating companies with a unique opportunity to gain valuable business insights for a modest investment. TEAM brings together the talents and enthusiasm of Canada's future arts, science, engineering, commerce and law leaders to address a sponsoring organization's challenges and advance its goals. For more information, see the TEAM web site http://team.appsci.queensu.ca/

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Disclaimer

The opinions and recommendations expressed are those of students and faculty at Queen's University and are not necessarily those of the client contact, CCPA, CSChE or the companies and organizations contacted during the project.

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FOREWORD

In June 2008 David Mody approached CCPA, explaining the Queen's University TEAM program and how it puts students from engineering, commerce, and law together to do small projects for industry, and asking if there was any interest in sponsoring a project for the upcoming academic year.

At the time CCPA had realized that funding constraints would prevent the association from continuing to provide the secretariat for the process safety management initiative in Canada, as it had done for almost two decades, and that much of the knowledge and experience gained was in danger of being lost because of the impending retirement of many key drivers of the initiative over the next few years. CCPA was about to start a brainstorming exercise with the process safety management division of the Canadian Society for Chemical Engineering to explore alternative ways of overcoming this challenge.

I thought it might be interesting to set a student team to work on the societal issue of how Canada should approach the control of major accidents, as the results would be very timely with CCPA's exercise and also with the twenty-fifth anniversary of the world's worst industrial accident – in Bhopal, India – coming up in December 2009. CCPA agreed, and this report is the result of that work.

The students were given an initial orientation and were provided with suggested sources and contacts to get them started, but were advised to take nothing for granted. Instead they were encouraged to keep an open mind, following their own leads and forming their own opinions as they gained more knowledge and an understanding of the background, issues, players and constraints. The result is therefore their own and as the disclaimer says, the opinions and recommendations expressed are those of the team and not necessarily the sponsors or those interviewed.

From the viewpoint of the client contact, this has been a fascinating and worthwhile exercise and I hope the students have found it as interesting as I have. I encourage others to take a look at the TEAM website, and to consider how they and their organizations can participate in TEAM in future years. I am sure they too will find it a rewarding experience.

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EXECUTIVE SUMMARY

Despite the developed state of industry in Canada, there are serious concerns about the state of process safety in this nation. Canada has never experienced a major industrial accident on the scale of that in Bhopal, India (1984), or Toulouse, France (2001); whether this is due to strong policies or good fortune is unknown. It is the intention of this report to first examine whether or not industry in Canada is effectively governed with regard to major industrial accidents involving hazardous materials. Secondly, the report makes recommendations to the CCPA as to how this aspect of industry safety can be improved if needed.

An assessment of the Canadian situation identified many of the weaknesses in the Canadian system. It seems the Bhopal report, however accurate in its content, failed to instigate all the change intended. Many of the issues identified remain prevalent problems in Canadian industry today.

This report also investigated major accident control outside of Canada. By reviewing policies in the United States, European Union, Australia and South Korea an understanding was garnered of effective policies in other equally-developed nations. It became clear, after reviewing international policies, that Canada has fallen short in its attempts to reduce the risk of major accident hazards.

In addition to policy research, interviews were conducted with members of different stakeholder groups. These interviews included industry executives and technical specialists, safety consultants, government representatives and emergency first-responders. It is the intention of the report to develop recommendations which effectively meet the needs of each of these stakeholder groups.

Upon completion of background research, a three-fold recommendation was developed and refined. The final recommendation is outlined below:

1. That the CCPA create a body which would audit, verify and generally conduct inspections for Canadian industrial facilities meeting threshold minimums.
2. That the CCPA lobby the federal and provincial governments (at the very least, the federal and Ontario governments) to cement a regulatory code of process safety management (PSM) practices. The provincial regulation should include a statement that any company falling within the thresholds must submit to mandatory membership to the new body.
3. That the CCPA lobby the federal government to create a body similar to the American Chemical Safety and Hazard Investigation Board (CSB).

This solution is heavily dependent on the CCPA, as it calls for a significant shift in the role of the association from acting as a lobby group to leading the formation of a body responsible for the management of process safety in Canada.

This recommendation also requires unobtrusive federal regulation mandating all companies abide by PSM. New provincial regulations will force companies carrying pre-determined threshold levels of chemicals to join the newly-created body established through the CCPA's expertise.

It was found that the state of major industrial accident prevention in Canada was generally insufficient. However, implementation of the above recommendations could help put Canada on a path to safer industry and more responsible government.

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1.0 INTRODUCTION

Canadians have always taken great pride in their country as a world leader in topics ranging from government supported social programs and environmentalism to economic and technological innovation and academic recognition. Despite Canada's place as a world leader in many of these endeavours, a comparison of policies aimed at preventing major industrial accident hazards across first-world countries shows that Canada is far below the levels of protection established by other jurisdictions. The importance of this issue is borne from a long history of industrial accidents which have caused personal injury or death for both employees and the general public. While Canada has never experienced an industrial accident on the scale of those in Bhopal, India (1984) or Toulouse, France (2001), history has shown that developed countries like Canada are not immune to these types of accidents. This project attempts to build a framework for the prevention and control of major industrial accident hazards in Canada by examining the broad engineering, business, legal and public policy issues behind this situation and potential approaches. These include:

- Why is Canada's situation so different from that in other industrialised countries?
- What roles should be played by the organisations operating hazardous facilities and those representing their industry sectors?
- What roles should be played by the competent authorities at the federal, provincial/territorial and municipal levels?
- What other actors should be involved and what should be their roles?
- What models exist in other jurisdictions for the broad issue of control of major accident hazards?
- What are the factors that influence how the lessons from elsewhere could be applied or adapted here?
- What is the best way for the relevant actors to address this issue, rather than waiting for a catastrophic incident to act as a driver?

This report will be addressing the degree of oversight and regulation of major industrial accident hazards in Canada, from the perspectives of government, industry bodies and the companies themselves. The process used for the report is to:

1. Identify any areas of improvement for Canada to meet the International Labour Organisation (ILO) and Canadian Society for Chemical Engineering standards.
2. a. Identify the major differences between Canada and other similar countries with regard to major accident hazard prevention and control.
   b. Analyse the underlying reasons for those differences.
3. a. Identify the key governmental, industrial and other players in Canada.
   b. Examine their current roles and changes if necessary to meet the ideal situation.
4. Recommend firstly whether a change is required, and secondly a methodology and process that should be taken to improve the regulation and control of major accident hazards in Canada such that Canada moves closer to the ideal situation.

The objective of the report is to provide a guideline for stakeholders to improve regimes for the control of major accident hazards in Canada. The report will make recommendations bearing in mind the potential conflicts between government, industry, academia and public opinion.

The report initially examines the frameworks present in other jurisdictions such as the United States, the European Union, Korea and Australia. The aim of this is to understand different approaches to successful major accident prevention regimes. The focus of the second section of the report is on Canadian stakeholders, representatives of whom are researched and interviewed with

the aim of understanding the vested interests of the different key players. These include businesses, industry bodies, levels of government, academics and the public. The final section of the report is comprised of policy recommendations based on comparative models, risk assessments, opinions of major actors involved and the costs of implementation. We hope to foster the growth of public policy positions on process safety through the use of our recommendations in this report.

The recommendations included in this report are intended to be enacted in a timely fashion in order to ensure a regime of compromise. While industry may view potential change as an increase in costs, we believe that businesses have a major interest in protecting their assets and in ensuring that appropriate legislation is passed. Should an accident occur before a new Canadian regime is set up, public reaction could force the government to pass onerous legislation leaving industry in a much less competitive environment than the pre-emptive one suggested in this report.

What this report is not about are issues of chronic risk, related to occupational or public health and safety, the environment or associated with products down a supply chain. For example, issues of ensuring proper protective equipment for workers or preventing contamination in a foodstuffs process that ends up poisoning consumers are issues that are beyond the scope of this report. In short, this report is addressing risks that could have immediate effects 'outside the plant fence.' The report has been commissioned specifically to deal with acute risks such as explosions, fires, sudden and unintended releases of toxic substances and so forth and should be read with an eye to preventing such incidents through controlling such hazards. While other types of risks are important for the process industries, they are best addressed by other approaches than those used here, and the analysis and proposed solutions will be very different.

2.0 BACKGROUND

2.1 Examples of Industrial Accidents (20th Century)

2.1.a Union Carbide – Bhopal, India (1984)

Major accident awareness internationally was spurred by the tragic Bhopal disaster in Bhopal, India on December 23, 1984. The Bhopal plant was owned and operated by Union Carbide India, Limited, an Indian company with Union Carbide Corporation as a majority shareholder. The plant was built in the late 1970s and produced pesticides for use in India.

On December 3, 1984, shortly after midnight, methyl isocyanate (MIC) gas was released from a tank in the plant. Approximately 3,800 people died and several thousand others experienced permanent and partial disability (Union Carbide Corporation Bhopal Information Center, 2008).

MIC is a highly dangerous chemical, with both reactive and toxic properties. The gas is highly flammable and forms an explosive mixture with air. As evidenced by the mass deaths after its release, the chemical is harmful if swallowed and severely burns the eyes and skin if contacted (PTCL Safety, 2005).

The release occurred when a large amount of water entered the MIC storage tank. The release was noticed by employees at 11:30 p.m., but the supervisor notified failed to take action. At midnight, 40 tonnes of MIC poured from the tank and spread over a city of nearly 900,000 people. On top of the nearly 4,000 people who died, estimates of those who suffered long-term effects from the release are as high as 400,000 (American University, 1997).

Officially, the Bhopal disaster was the result of a combination of legal, technological, organisational and human errors. Unreliable temperature and pressure gauges were ignored, refrigeration units were ineffective, the gas scrubber used to neutralise escaping MIC was shut off, the flare tower was turned off, the water curtain ineffective, warning systems were ineffective and finally, the tank was filled beyond the recommended capacity. Although Carbide claimed a disgruntled employee was responsible, the negligent behaviour of the company likely contributed to the consequences of the accident (American University, 1997).

The overwhelming tragedy of the Bhopal disaster spurred action among developed nations to evaluate the state of their emergency preparedness and process safety management (PSM). Many of the regulations and voluntary initiatives around the world were developed in response to this tragedy.

2.1.b Phillips Petroleum – Pasadena, Texas (1989)

On October 23, 1989, 23 people lost their lives and more than 100 people were injured in Pasadena, Texas. The cause of this tragedy was an explosion and ensuing fire at the Phillips Petroleum Houston Chemical Complex. According to the U.S. Department of Labor, in addition to the tragic loss of life and injuries, the explosion caused nearly three-quarters of a billion dollars worth of damage. Two polyethylene production plants were destroyed and buildings a half-mile away experienced shattered windows due to a physical shock equivalent to an earthquake registering 3.5 on the Richter Scale (Dole, 1990).

The Phillips complex produced high-density polyethylene, a plastic used to make plastic containers. Prior to the incident the facility produced approximately 1.5 billion pounds of plastic each year.

According to the United States Fire Administration National Fire Data Center the explosion was caused by the failure of a 10 inch line carrying ethylene and/or isobutene. The pressure in the pipe could have been as high as 700 pounds per square inch (Yates, 1990). During regular maintenance

on one of the plant's polyethylene reactors more than 85,000 pounds of these highly flammable gases were released through an open valve, forming a vapour cloud. Within 90 to 120 seconds, the vapour cloud came into contact with an ignition source and exploded with the force equivalent to 2.4 tons of TNT (Dole, 1990).

An Occupational Safety and Health Administration (OSHA) investigation revealed internal company audits had previously identified unsafe conditions, but were ignored. The investigation also revealed a lack of management systems that resulted in the inability to:

- Prevent the uncontrolled release of flammable vapours.
- Minimise the effects of a release of flammable vapours, including the elimination of position ignition sources.
- Provide adequate fire protection.

A settlement between OSHA and Phillips 66 led to the latter paying a $4 million fine and an agreement to institute PSM procedures at HCC and the company's sister facilities through Texas and Utah.

2.1.c Azote Fertilizant – Toulouse, France (2001)

Azote Fertilizant (nitrogen fertilizer) was the name of a fertilizer company near Toulouse, France. On September 21, 2001 a massive explosion occurred, totally annihilating two entire buildings and leaving a crater 20 to 30 meters deep and 200 meters across. Thirty people were killed, 50 were critically injured and 2500 seriously wounded. According to reports, two thirds of the city's windows were shattered and 10 per cent of the city's population (4000 people) were made homeless.

The explosion was triggered when a mix of sodium dichloroisocyanurate and ammonium nitrate was dumped on a stockpile of 300 tonnes of additional ammonium nitrate. A combination of cases of negligence was indicated for the incidents. Several reports mentioned long term concern about the safety of the plant though this unfortunately was not followed up.

According to Gema, the group of mutual insurers, the estimated cost of the explosion is expected to be around 97million Euros (Financial Times World Media, 2002).

2.1.d BP Refinery – Texas City, Texas (2005)

BP's Texas City Refinery is the third largest oil refinery in the United States, processing 460,000 barrels of crude oil per day (BP America, 2008). On March 23, 2005 a fire at the facility's isomerisation unit cost 15 people their lives and injured 170 more.

According to the BP America report, "The incident was caused by heavier-than-air hydrocarbon vapours combusting after coming in contact with an ignition source, probably a running vehicle engine." The report explains that the failure to take effective emergency action resulted in the loss of containment that preceded the explosion. Failure to follow many established policies and procedures, inadequate supervision and crowding of bystanders allowed the consequences to escalate to such proportions. The likelihood of this incident could have been reduced by installing inherently safer options, which were available at the time. The report also claims the working environment at the plant was resistant to change, process safety and systemic risk reduction. Complex organisation left individuals unaware of their responsibilities and poor communication led to inadequate warning systems. Finally, an insufficient level of hazard awareness and PSM resulted in people accepting higher levels of risk than that of comparable installations (Mogford, 2005).

The outcome of this disaster for BP specifically was a thorough analysis of management structures and procedural systems (more information can be found in the Baker report in the references). For developed nations in general, this disaster reminded industry of the fallibility of their systems and

the importance of risk management (Mogford, 2005). During the research for this TEAM project, several of those interviewed commented specifically on this accident and how an event of similar proportions in Canada could cause government to react with drastic, "knee-jerk" legislation to appease public concerns.

2.1.e CAI Inc – Danvers, Massachusetts (2006)

On November 22, 2006 an explosion in a chemical plant in Danvers, Massachusetts damaged nearly 90 buildings in a busy municipal area. Fortunately, there were only minor injuries, sending 10 people to hospital. According to Governor Mitt Romney, the explosion was equivalent to a 2,000-pound bomb going off.

The explosion occurred at CAI, Inc., a chemical company making solvents and ink. According to the Massachusetts Department of Environmental Protection Investigation the most probable cause for the explosion was a chemical vapor explosion of overheated heptane vapor. The ignition source was undetermined, but several potential ignition sources existed in the building. The heptanes explosion initiated a chain reaction of other chemicals detonating, leading to the complete destruction of the building (Massachusetts Department of Environmental Protection, 2007).

2.1.f Imperial Sugar Refinery – Port Wentworth, Georgia (2008)

A massive explosion occurred at the Imperial Sugar refinery in Port Wentworth, Georgia on February 7, 2008. Fourteen deaths are attributed to the explosion and 38 people were injured. The explosion was fueled by massive accumulations of sugar dust throughout the facilities (U.S. Chemical Safety and Hazard Identification Board, 2008).

The Chemical Safety and Hazard Identification Board (CSB) investigation is still underway, however the explosion has been attributed to fine sugar dust, which can become combustible if it is too dry and a static charge accumulates. This incident prompted the CSB to propose that the US Occupational Safety and Health Administration (OSHA) adopt the CSB Recommendation on Comprehensive Combustible Dust Standard.

2.1.g Sunrise Propane – Toronto, Ontario (2008)

Despite the focus thus far in this report on international incidents, Canada is not immune to accidents, nor have they completely avoided them in the past. On August 10, 2008 Sunrise Propane, located in a suburb of Toronto, Ontario experienced an enormous blast. The strength of the explosion launched tanks twice the size of rail cars off their mounts; one was projected offsite into a nearby City of Toronto works yard. The end of one of the tanks ended up embedded in a road-salt dome some 500 meters away. The incident caused the closure of Highway 401 and the evacuation of 12,500 people from their homes. Two people died due to the accident, however it is shocking that more were not affected due to the size of the blast and the fact that it occurred in a metropolitan area (Hosty, 2008). An investigation into the explosion by several offices found propane was being transferred directly between tanker trucks, a practice prohibited in Ontario. Further, it was determined that this unsafe practice was routine at the facility (Marshall, 2008).

The legal issues surrounding this incident are as yet unresolved, and even the exact cause of the explosion is not certain, although many articles mention a boiling liquid – expanding vapour (BLEVE) situation, or problems with the truck-to-truck transfer. The Technical Standards and Safety Authority (TSSA) revoked Sunrise Propane's licenses to operate shortly after the incident because Sunrise had been warned about their unsafe practices previously and failed to comply with 'cease and desist' notifications.

As this is a very recent incident, the investigative work is incomplete. Canada was very lucky more lives were not lost, however, it is clear that this country is not immune to major accidents and therefore the state of the system of control in Canada must be addressed.

2.2 Current State of Affairs in Canada

2.2.a Overview

The Canadian situation is one in which there is effectively no regulation of major industrial hazard issues on a more than an ad hoc and/or voluntary basis. The Canadian Chemical Producers' Association (CCPA) is an industry group (membership is voluntary) that attempts to provide guidance and best practices for the industry; nothing compels any company or plant to follow CCPA guidelines, though CCPA members are expected as a condition of membership to commit to and meet or exceed a certain standard. If nations which are developed enough to be members of the Organisation for Economic Co-operation and Development (OECD) all have some sort of government instrument dealing with chemical hazards, it must be asked why Canada does not have the same kinds of regimes in place. The ultimate goal of this project is to make recommendations on possible changes to the current system.

Currently, Bill C-45 is the major criminal-related legislation in place with regard to major chemical accidents (Creedy et. al., 2003). The good fortune of having few accidents has meant there have been few prosecutions to date under this piece of legislation. This means that Canada is left without precedents for determining what charges for major accidents would look like. There are also exceedingly few cases of civil lawsuits with regard to chemical accidents in Canada. The most relevant lawsuit is the one filed against Sunrise Propane with regard to the accident that occurred in summer 2008. The case is still proceeding through the certification stages as this project proceeds. For the most part, lawsuits involving process industry accidents would likely certify.

The main piece of non-criminal legislation and/or regulation that the process industries deal with on a day to day basis is what is known as the Canadian Environmental Protection Act Section 200 (CEPA 200). Essentially, this legislation creates a list of chemicals and threshold quantities that require reporting to the government. Unfortunately, while many companies comply with the CEPA 200 guidelines, many do not believe the system does much to actually improve safety. It appears that the regime has created a system where a person doing the inspection fills in numerous forms, which are sent in to show the company is complying. The problem is that industry players do not seem to know what happens after this point (this is a major concern of industry which will be analysed later in the report). If the state is simply creating more paperwork, the goal of increasing safety is not being achieved. Further detail on the exact content of this section of CEPA, its costs and benefits, and its relevance to our recommendation will be provided later in the report.

One of the unique features of the Canadian political landscape is that a federal system exists that sees the provincial government in charge of property and civil rights, while the federal government has powers over trade and commerce (Constitution Act, 1867). Additionally, the federal government has what is known as the peace, order, and good government clause (POGG clause); they can make laws for the 'peace, order, and good government of Canada.' However, this is a much more narrow power than it appears on paper, and the federal government cannot use POGG whenever it wishes. It is far from a 'blank cheque'; there must be a national concern that provinces are unable to address on their own (R v. Crown Zellerbach case, 1988). To use an analogy, there has been talk of having a federal securities regulator for years; Canada is one of the few countries in the world which regulates securities on a non-federal level of government.

The federal government cannot simply invoke POGG to assert jurisdiction. It is estimated that only about 10 per cent of the Canadian work force is regulated by federal legislation (Labour Law casebook, 2004).

Given these factors, a 'made-in-Canada' solution involving the state will require close cooperation from the two levels of government. This would ordinarily be an incredibly difficult task, but the current public sentiment in Canada seems to prioritise safety as a major concern. With incidents such as explosions, food contamination issues, products made with dangerous substances among other things on the public consciousness, the political climate is favourable to lobbying for more regulation. Moreover, as will be addressed in the recommendation of the report, the lobbying effort should not require mobilising to lobby numerous provinces. Care must be taken, however, not to give in to potential public demands by implementing poorly thought-out legislation or regulation that is politically expedient and popular but does little to address the actual issues.

Solutions satisfying both the state and private actors have to be kept in mind. This section has attempted to provide an overview of the Canadian situation as it exists, with an emphasis on current weaknesses. These should be kept in mind when reading the following sections on other jurisdictions and the recommendation of the report.

2.2.b The Bhopal Aftermath Review Project

The Bhopal aftermath review is an extensive document written by an industry/government steering committee in 1985. The steering committee was made up of individuals from Environment Canada, Agriculture Canada, Petro Canada, the CCPA, Transport Canada, and others. The purpose of the report was to examine the potential for Bhopal-type incidents in Canada, review measures taken by industry and governments to prevent such accidents and assess the collective ability of industry/government to respond. According to the report, although review of accidents after they happen is important, foresight is a far more important approach. As an unnamed loss prevention expert stated in the Review Project, "Organizations have no memories" and therefore preventative action is the best defence against accidents.

The report listed a series of lessons taken from the Bhopal disaster which must be addressed:

1. The Bhopal disaster provided direction for the committee to outline the criteria for identifying chemicals with inherent risk. Despite Canada's rather safe history, Canadians should not become complacent as the possibility for an incident like Bhopal is always present even in Canada.
2. Canadians must find ways to maintain existing, and implement new, siting and land-use control plans to ensure zoning and planning decisions are made with potential industrial hazards in mind.
3. All plans must apply hazard analysis and risk management techniques in the assessment of processes and operations. Management must also be upfront about the cost of accidents and industry should recognize the benefit of implementing safety audit systems.
4. The public both wants, and has a right, to know whether chemicals are present in a near-by process and what potential there is for hazards. The public should also be informed of the safeguards in place.
5. An adequate warning system must be implemented to alert the community if an accident does occur. Following this a clear and comprehensive contingency plan is needed for both the plant and the nearby community.
6. Steps must be taken to ensure local medical staff in hospitals are knowledgeable in the methods required to treat victims of the most probable chemical releases. There must also be supplies for treatment available on short notice.

The report developed 21 recommendations to be implemented to avoid a Bhopal-type accident occurring in Canada. It also emphasised the need for leadership and coordination to ensure the lessons above and recommendations below are kept in the forefront of the minds of industry and government alike. The report suggested a task force of senior level officials from appropriate departments (federal and provincial), representatives of industry, and community interest groups be established to evaluate the implications of the recommendations. The task force should also coordinate, or at least monitor, specific activities that are undertaken and report progress made.

As mentioned the report listed 21 recommendations Canadian industry should consider in decreasing their risk of major industrial accidents. Listed below are the most important recommendations with regard to the scope of this particular project:

1. Dangerous chemicals should be classified and, using this information, risk assessment should be completed with the participation of municipal officials.
3. By helping one another, industry should determine the actual status of safety and accident prevention programs.
4. Companies should minimize unnecessary storage of dangerous chemicals, share information to increase awareness, and ensure personnel are well-trained.
6. Contingency plans and planning guidelines should be developed by chemical industry, as well as those companies involved in transport.
10. First responders should be trained to access chemical expertise before attempting to control unfamiliar chemicals or mixtures. Training for first responders should include information about high-risk chemicals in regions where necessary.
11. Municipalities should introduce effective zoning regulations and maintain these buffer zones.
13. The CCPA should develop programs for their companies based on Community Awareness and Emergency Response by the U.S. chemical industry.
14. The federal government should provide guidance to municipalities on how to prepare emergency response plans, provide financial support if necessary and maintain inventories of emergency response equipment.
20. Scientific and engineering professionals should receive training in accident and loss prevention.

In general the Bhopal review was an extensive report listing many weaknesses with regard to safety in Canadian industry. Unfortunately, reading through the report one notices the similarities between the weaknesses recognized 20 years ago and the weaknesses still existing today. It seems this report accurately identified areas for improvement within Canadian process safety but they were not remedied.

Despite Canada's fortunate history with very few accidents, the recommendations from the Bhopal review need to be taken seriously even today. As Canadian industry has grown, it seems our safety standards have not been able to keep up, putting all Canadians at unnecessary risk.

From the report a body in Canada was formed called the Major Industrial Accidents Council of Canada (MIACC). Although no longer active, MIACC was formed to consider whether Canada was at risk for a major industrial accident similar to the tragedy in Bhopal. This body is discussed more thoroughly below.

2.2.c MIACC Formation

The recognition that control of major accident hazards could not be regulated by a single agency led to the establishment in 1987 of a voluntary multistakeholder organization – the Major Industrial Accidents Council of Canada (MIACC). MIACC's role was to provide a model for industry in Canada by creation of consistent industrial prevention, preparedness, and response programs.

MIACC was able to gather a diverse and influential membership from all areas of Canada's industrial base. These included politicians from federal, provincial and municipal governments. There were also representatives from almost every industrial sector, including chemical producers, pulp and paper, oil and gas, mining, utilities and transportation. MIACC's membership also included academia and several community representatives, as the public were viewed as critical stakeholders in the outcome of the project.

MIACC's objective was to create a public safety management framework as soon as possible, while still giving industry time to undertake the changes both in management and operation. The organisation had no set deadlines for publications and research releases; the goal was to continually try to improve standards and conditions as the circumstances in Canada changed. These circumstances included industry requirements, government requirements, or a change in public interest.

MIACC published a classification of hazardous substances into three distinct lists:

- List 1: Priority Hazardous Substances
- List 2: Hazardous Substances
- List 3: Environmentally Hazardous Substances

The basis of these classifications was the diverse and expert opinion from the membership base of MIACC who had involvement in the areas of toxicology and health, health and safety, emergency response plans and enforcement.

The MIACC lists were critical as they provided a method to easily classify companies within a broad industry. The various industrial classifications have their own process safety management requirements, as a company which handles dangerous chemical substances typically has a different set of associated risks and technical knowledge on site than a pulp and paper mill or a propane depot.

MIACC also published other guidance including a risk assessment methodology for municipalities and industries, a Canadian standard on emergency planning for industry, risk-based land-use planning guidelines for municipalities, a process safety management guide and self-assessment tools by which industries and communities could assess their status at one of three levels and identify gaps in their performance.

The last two items were particularly important as they were the basis for commitment by all of MIACC's stakeholders in 1998 to having all industry sites and the communities in which they are located meet the minimum "essential" level by 2003 and to later to progress to the higher levels (MIACC, 1998). See the table below.

Table: **MIACC Five Year Goal Outline**

Item	Actual 1998	1999	2000	2001	2002	2003
List 1 Sites*	512	800	1050	1250	1500	1700
Sites Reported at Essential Level*	0	10%	25%	50%	75%	100%
Sites Reported at Enhanced Level*	0	5%	10%	20%	35%	50%
Sites Reported at Excellent Level*	0	2%	5%	10%	17%	25%
List 1 Communities*	316	350	450	550	600	650
Communities with Joint Coordinating Committees	97	25%	50%	75%	100%	100%
Communities Reported at Essential Level*	0	10%	25%	50%	75%	100%
Communities Reported at Enhanced Level*	0	5%	10%	20%	35%	50%
Communities Reported at Excellent Level*	0	2%	5%	10%	17%	25%

* MIACC did not apply the criteria for the Essential, Enhanced and Excellent Levels of Prevention, Preparedness and Response for Sites and Communities during 1998. The target numbers for List 1 Sites and Communities presented in this table were based on the belief at the time that there were over 2000 List 1 sites in Canada. The targets were to be adjusted annually to more accurately reflect the findings of research conducted throughout the initiative.

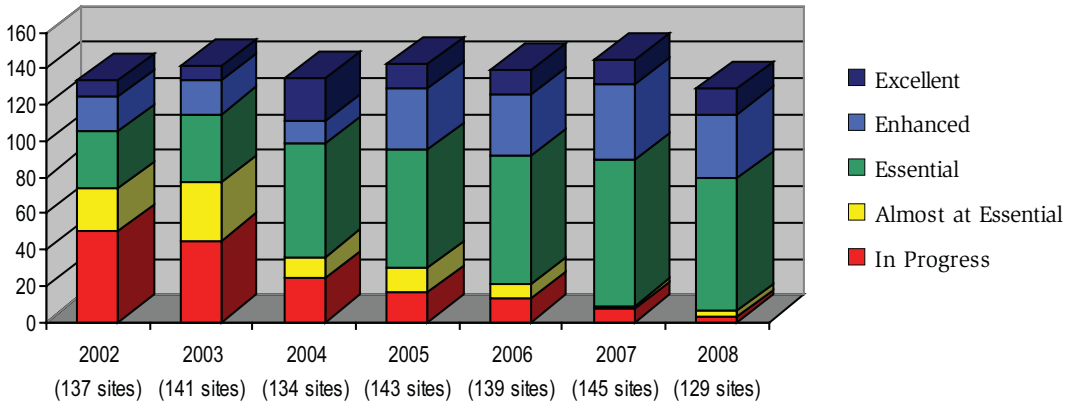
In 1999, however, MIACC dissolved. The main reasons for the collapse were governance issues and a lack of funding, as external stakeholders became unwilling to further financially contribute to the project. Stakeholders agreed to dissolve the organisation, as well as to dispose of the intellectual property, which was split between the Canadian Association of Fire Chiefs (CAFC) and a newly-formed Process Safety Management Division of the Canadian Society for Chemical Engineering (CSChE). In 2005 CAFC decided it was unable to continue supporting the work and transferred its intellectual property to the CSChE.

The MIACC lists subsequently became the basis for regulation under Section 200 of the Canadian Environmental Protection Act (CEPA) in 2003, so they have been preserved through regulation, though the performance standard set by Section 200 is far less than the essential level of the 1998 MIACC voluntary stakeholder commitment. In terms of communities, only Ontario has formally followed through, requiring all municipalities in the province to meet the essential level under the Emergency Management and Civil Protection Act 2006.

Of the industry stakeholders, only the CCPA continued with the target of meeting or exceeding the essential level, which took longer than expected despite a commitment from the CCPA board of directors. (See PSM Performance by Self-Assessment Level below.) It is likely that other industry sectors are below this standard.

Figure: CCPA PSM Performance by Site Self-Assessment Level

Status as of Aug 2008 compared with previous years
(some site changes)
Target for meeting Essential level: June 30, 2003



3.0 ELEMENTS OF AN EFFECTIVE SYSTEM FOR CONTROL OF MAJOR INDUSTRIAL ACCIDENT HAZARDS

With regard to a system for the control of major accident hazards, there are two main areas of focus: who is affected and what are they supposed to do (or not do). Since it is difficult for a company to independently identify and educate all external stakeholders regarding the industrial process, guidance is provided by the International Labour Office (ILO) and the Organisation for Economic Co-operation and Development (OECD).

3.1 ILO Convention

The ILO Prevention of Major Industrial Accidents Convention, 1993 provides an overview of broad controls. The accompanying code of practice explains the coverage of the convention in more depth. The scope of the ILO code of practice can be seen below (ILO, 1991):

1. Scope and Definitions
2. General Principles
3. Responsibilities of Employers
a. Identification
b. Notification
c. Arrangements at the Level of the Installation
d. Safety Report
e. Accident Reporting
4. Responsibilities of Competent Authorities
a. Off-site Emergency Preparedness
b. Siting of Major Hazard Installations
c. Inspection
5. Rights and Duties of Workers and their Representatives
6. Responsibility of Exporting States
7. Final Provisions

Primary roles set out by the ILO pertain to responsibilities of the employer, site operator and related authoritative bodies. Subsidiary roles are also played by workers and by those who are able to influence the behaviour of site operators, as in the examples that are listed below.

- Professional societies
- Responder organisations (fire, emergency measures)
- Insurance
- Consulting
- Standards organizations
- Other service providers
- Educators (universities, community colleges)
- Activist community (environment, labour)

3.2 OECD General Guidance

The overall goal of the OECD is for better regulation and structural reforms for industrial sites to improve national economies by giving them the flexibility to adapt to economic change (OECD, 2008). The initial set of guiding principles included a set of regulatory and policy tools, methods for improving market competitiveness and methods for government to lower regulatory burdens. These broad principles and objectives are listed below (OECD, 2008).

1. Adopt at the political level broad programmes of regulatory reform that establish clear objectives and frameworks for implementation.
2. Assess impacts and review regulations systematically to ensure that they meet their intended objectives efficiently and effectively in a changing and complex economic and social environment.
3. Ensure that regulations, regulatory institutions charged with implementation and regulatory processes are transparent and non-discriminatory.
4. Review and strengthen where necessary the scope, effectiveness and enforcement of competition policy.
5. Design economic regulations in all sectors to stimulate competition and efficiency, and eliminate them except where clear evidence demonstrates that they are the best way to serve broad public interests.
6. Eliminate unnecessary regulatory barriers to trade and investment through continued liberalization and enhance the consideration and better integration of market openness throughout the regulatory process, thus strengthening economic efficiency and competitiveness.
7. Identify important linkages with other policy objectives and develop policies to achieve those objectives in ways that support reform.

3.3 OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response

Similar guidance to the ILO model is provided by the OECD, which provides advice related to the role and responsibilities of public authorities, industry, employees and their representatives, as well as interested parties such as members of the public potentially affected in the event of an accident, and non-governmental organisations. For specific information, refer to the OECD website (OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response, 2003).

3.4 Regulatory and Voluntary Requirements

It is important to note from the ILO code of practice and pertinent actors outlined above that control of major accident hazards calls for a combination of regulatory and voluntary requirements. Regulation alone is not sufficient to improve the current situation regarding PSM in the process industries.

It can be seen from the discussion above that actors differ both in their roles but also in the nature of their control, which can be direct and indirect control. Site operators and engineers who design the equipment in use have direct control over the potential for a serious accident. Indirect actors, such as government inspectors, have the ability to influence the process by offering guidance and feedback, but cannot control the process for the site operators.

This, and the fact that control is by a combination of both regulatory and voluntary measures, is of great importance as regulations are the visible means by which the government and public can judge the safety of an industrial facility. This judgment is actually based on only indirect controls and does not take into consideration the voluntary actions by a company – the direct control that has a far greater influence on the safety of the process. Some facilities in Canada may undertake numerous voluntary initiatives and benchmarks, whereas others may perform the bare minimum. This creates an unfair industry practice, and the performance of good actors can give the impression that facilities are safe when an individual company or site may be well below the general standard.

Examples of regulatory controls for the control of major industrial accident hazards include:

- The Canadian Environmental Protection Act, Section 200
  - Section 200 allows the Government of Canada to establish a list of substances that, if they enter the environment, may harm the environment (CEPA, 1998).
- The US Environmental Protection Agency (EPA) Risk Management Program
  - The EPA Risk Management Program requires that all facilities which produce, handle, distribute, or store specific chemicals are required to prepare and submit a Risk Management Plan to the EPA for review.
- The US OSHA 1910.119 Process Safety Management Rule
  - Provides requirements for preventing and minimizing the consequences of acute releases of toxic, reactive, flammable or explosive chemicals (OSHA, 1996).

Examples of voluntary measures for the control of major accident hazards are provided in supplementary information published by regulatory agencies (which is intended as guidance rather than part of the regulations themselves), as well as in standards, recommended practices and private initiatives. Standards and benchmarks are provided by third-party organisations, such as the CSChE, and are intended to supplement any regulatory requirements. They are also often developed by or for specific companies or industry sectors.

Examples of this voluntary guidance include:

- The Implementation Guidelines for Part 8 of the Canadian Environmental Protection Act, 1999
  - Environmental Emergency Plans
- Canadian Society for Chemical Engineering (CSChE)
  - Process Safety Management Guide
  - Site Self-Assessment Tool
- Publications by the American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS)
  - Proactive group which focuses on process safety publications which can be used in the development of a PSM plan by industrial facilities (ex. Guidelines for Hazard Evaluation Procedures).

4.0 LESSONS FROM OTHER JURISDICTIONS

4.1 United States of America

As the United States provides a number of "best practices" for industry around the world, it is important to look at the state of American regulation. It should be noted, however, that there has been significant criticism in recent years of U.S. hazardous substances laws.

There are numerous agencies and legislation and regulations in the U.S. dealing with hazardous substances usage in industry. The Toxic Substances Control Act (TSCA) is the main federal law regarding industrial chemicals. This TSCA legislation is under the umbrella of the U.S. EPA. The EPA also holds jurisdiction via its Risk Management Program (RMP). The RMP forces all facilities that are using threshold levels of dangerous materials to have risk plans in place that detail fail-safes to prevent accidents and contingency plans to execute if accidents do happen. Other pieces of legislation include the Emergency Planning and Right to Know Act, which led to the Toxics Release Inventory (TRI). The TRI tries to make information regarding potential hazards accessible to all.

A second federal level agency that deals with major industrial hazard accident hazards in the U.S. is OSHA. The combination of the EPA and OSHA in the U.S. leads to some rather confusing regimes of tracking and enforcement. As the TSCA is the main act, the EPA has the main jurisdictional oversight, but it categorizes sites into three "classes." The class 3 sites are the most "hazardous" and here jurisdiction switches to OSHA; it is class 3 that requires PSM regimes. Depending on the classification of a site, it is subject to different regimes of reporting, inspection, punishment, etc. Consequently, if a plant decided to undertake an aggressive growth strategy, it could find itself suddenly subject to a different regime. On a sub-federal level, some states and even counties or municipalities have laws or bylaws with regard to hazardous materials. These regulations are similar to sub-federal Canadian laws; they add on to the federal law, taking into account the unique needs of the locale. The state of New Jersey, for example, has its "Toxic Catastrophe Prevention Act" which provides for stringent regulation of the state's industrial facilities given that New Jersey is a small state and many facilities are located near important transport arteries.

The US regulation on chemical hazards focuses on sets of chemicals that are deemed to be dangerous and combines this list with a quantity "threshold." As government does not have the requisite expertise in industry matters, it makes tactically vague regulation. The American regulations provide a regime where government is involved in setting standards of a general nature. For example, a part of OSHA Regulation 1910.119 Process Safety Management rule reads:

"This section applies to the following:

- 1910.119(a)(1)(i)
  A process which involves a chemical at or above the specified threshold quantities listed in Appendix A to this section;
- 1910.119(a)(1)(ii)
  A process which involves a flammable liquid or gas (as defined in 1910.1200(c) of this part) on site in one location, in a quantity of 10,000 pounds (4535.9 kg) or more except for:
- 1910.119(a)(1)(ii)(A)
  Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard;"

The text continues on with lists of types of hazardous substances.

The other major development in the US on this issue was the creation of the Chemical Safety and

Hazard Investigation Board, known as the Chemical Safety Board (CSB). The CSB became operational in 1998. This body conducts investigations and is regarded as one of the most independent of government bodies. However, it has little power in the realm of enforcement capabilities. Consequently, it needs the cooperation of another body (whether government or private) to actually sanction offenders. That being said, it is still useful to have a government resource that makes available to the public the scope and nature of accidents. Moreover, the CSB has pushed OSHA and the EPA on issues not often seen as hazardous, such as dust explosions from seemingly innocuous facilities.

The legislative and regulatory framework in the U.S. is not one Canada should implement as a whole. First, 90 per cent of the U.S. work force comes under federal jurisdiction (Labour Law casebook, 2004). Second, it is important to note that the U.S. does not have a unified inspection regime like that in such nations as Korea (discussed below). The number of bodies and overlapping legislation in the US create jurisdictional issues and confusion. Additionally, enforcement is lacking even with all the agencies that have been created. Finally, even if these issues were settled, the probability of significantly more agencies being created by the government of Canada is not realistic. The section in the report discussing policy options will, however, touch on aspects of the U.S. system that some of those we interviewed found to be beneficial.

Perhaps the best takeaway of the U.S. system is found not in its system of regulation, but its tort law system. The U.S. is unique in that it is one of the few countries in the world to use significant punitive damages in its legal system. Punitive damages are awarded to punish defendants in civil lawsuits where the court believes conduct has been particularly egregious. As the purpose of the project is centred on prevention and control, tort law is not the best solution. However, it is significant for its potential deterrent effect. Having some sort of system that punishes negligence 'beyond the fence' with heavier-than-normal damages would be an additional deterrent to companies that may be tempted to scrimp on safety.

4.2 European Union

In Europe the controlling legislation in the major hazard area is the Seveso II directive. It calls for a two-tier system in which land-use planning is mandatory for all facilities and the top-tier facilities are inspected annually. Lower-tier companies are required to have a major accident prevention policy and upper-tier companies must submit a detailed safety report.

What makes the European situation interesting is that Seveso II is a minimum standard and countries modify the plan when they implement it. This leads to a fragmented set of regulations throughout Europe with different countries having vastly different plans. For example, France assesses facilities based on the damage caused by a worst-case scenario accident and ignores the probability of such an accident occurring, a very interesting philosophical approach.

Essentially, the European legal system has set up a number of chemical requirements at several different levels, from the municipal up to the continental. The patchwork of laws results in jurisdictions, levels of enforcement and requirements that all vary based on location and time. What seems to be the basic summation is that if one works with chemicals in any industrial capacity the presence of the chemical must be reported to government regulators and a safety plan must be developed (be it a plan to phase out the chemical, or a plan to make its use safer).

Finally, it is important to mention the Registration, Evaluation and Authorisation of Chemicals (REACH) directive. While this legislation is not targeted at process industry companies and in fact does not target accidents at all but rather the long term health consequences of chemicals, it is extremely complex legislation that could easily be read to apply to process industry companies, especially in the long term. The most dramatic effect of REACH is that if a chemical is deemed to be

dangerous, industry will need to seek government permission to use it. As of yet there is no list of "dangerous" chemicals so it is impossible to know just how large the scope of this legislation is and its impact on process industry companies.

4.3 Australia

Australia is often compared to Canada in terms of control of major industrial accidents because the government structures are so similar. Both countries have federal and provincial governments with each level having different areas of authority and responsibility. In both Canada and Australia the control of major accident hazards is basically a provincial, not a federal, area of responsibility.

The Australian federal legislation on this matter is interesting in that it is non-binding and to be put into effect it must be adopted by the states. However, it provides a ready-made and instantly available framework should the provinces want to implement a PSM requirement.

The text of the legislation itself is fairly lacklustre. It does not deal with many of the elements needed in a good PSM system and instead focuses on reporting, notification and development of safety plans. Realistically the legislation's purpose is to have companies seriously think about safety issues and potentially instil in them the sort of safety culture necessary for them to independently adopt a full PSM scheme.

4.4 South Korea: Process Safety Management

4.4.a Industrial History

The current industrial situation in South Korea varies quite differently from that in Canada, mainly because South Korean industry is based around family-owned industry rather than corporate entities (U.S. Department of State, 2008). During the 1960s instability in North Korea and Vietnam created a need for South Korea to modernise its military, and the government formulated an economic plan to develop heavy and chemical industries. Banks were directed to provide low-interest loans to family-owned conglomerates, which eventually dominated the free-market industry. This provided an industrial environment where profit was more important than process safety, and the conglomerate essentially defined process safety management in South Korea. In the late 1980s and early 1990s the rising amount of fatalities and destroyed communities resulting from chemical site explosions caused the South Korean public to advocate a regulatory regime from the government. As a response to public pressure the government developed federal regulations for process safety management (Cha Myung, 2008).

4.4.b Regulation Outline

Federal intervention was provided in the form of the Minister of Labor reviewing safety report forms provided by all industry. According to a Korean Occupational Safety and Health Agency (KOSHA) and Europa joint documentation release the following sections on regulatory procedure, process safety report outline and enforcement descriptions formulate the basis of the federal regulation:

1. An employer of hazardous installations shall submit the process safety report to the Ministry of Labor/KOSHA under the Presidential Decree for preventing major industrial accidents such as fire, explosion and release of toxic chemicals which can cause a serious danger to employees, residents in the nearby community.
2. The process safety report prepared by the employer shall be reviewed by the Safety and Health Committee in the workplace before submission. If the committee has not been established, the report shall be reviewed by the representative of employees.

3. The Ministry of Labor/KOSHA shall assess the process safety report and can order the employer to change the report in case it is necessary for the safety and health of employees
4. An employer and employees shall take necessary measures in compliance with the process safety report.

The process safety report to the Ministry of Labor contains the following elements:

1. Process safety information
2. Hazard analysis and risk assessment report
3. Procedure and planning for safe operations for installations
   - Procedure and manual for safe operation
   - Procedure and specification for mechanical integrity
   - Procedure for hot work permit
   - Safety control procedure for contractor's work
   - Education and training plan
   - Procedure for management of change
   - Procedure for pre-startup
   - Audit procedure
   - Procedure for incident investigation
   - Others related to safety management
4. Emergency planning and response

4.4.c Role of Professional Engineering Body

The evaluation of process safety reports and the inspection of facility sites are performed by a professional engineering body organised by the Korean government. This professional body has several roles including researching accident prevention techniques, technical assistance for industrial facilities, analysis of hazard prevention plans, and safety culture promotion (KOSHA, 2009).

To ensure the companies are following their process safety report guidelines, Ministry verifiers randomly check approximately 500 industrial sites per year. These sites are given a ranking: Progressive, Stagnant and Mismanagement. Progressive companies are allowed to continue their self-implemented process safety management regimes. Stagnant companies are verified more than once per year to check on the status of their process safety management implementation. Mismanagement companies are verified more than twice per year and are given technical advice by the Ministry. Furthermore, process safety management training is required every six months.

4.4.d Effectiveness

According to a news release by the KOSHA, since the implementation of the aforementioned federal regulations the numbers of fatalities, injury rates, and near-hits were decreased by 62 per cent, 58 per cent, and 82 per cent respectively. Additionally, technical data, such as P&IDs[1] and HAZOP[2], were improved. The number of emergency shutdown cases was decreased and property damage was reduced.

[1] A Piping and Instrumentation Diagram - P&ID, is a schematic illustration of functional relationship of piping, instrumentation and system equipment components (Engineering Toolbox, 2005).

[2] Hazard and operability studies (HAZOP) are a methodology for identifying and dealing with potential problems in industrial processes, particularly those which would create a hazardous situation or a severe impairment of the process (Wikipedia, 2009).

5.0 ISSUES, INTERESTS AND CONSTRAINTS

5.1 Stakeholder interest

This project takes into account three major stakeholders: the governments of Canada and the provinces, the process industries and the general public. The final recommendation must be publically palatable for the Canadian government and cost effective for Canada's process industries, and must ensure the safety of Canadian citizens. While these issues each target a specific stakeholder, each issue has repercussions for all stakeholders.

5.1.a Government

The Canadian government is most concerned with how this issue is currently viewed by stakeholders, and how any changes to the current situation will be viewed by the public in both the short- and long-term. The government plays a mediating role in our society, balancing the interests of different groups in the manner determined to be best for Canada moving forward. Accordingly, the government's main concern is ensuring the wellness of the majority, but beyond this they have some major conflicts relating to the other issues as well. The public may be happy with the current safety regime in Canada, but if a major accident occurs and causes widespread property and environmental damage, as well as injury and death, the government could find itself with a major problem. At the same time, if the government puts overly rigorous controls on the process industries, there is a chance that companies will move operations to other countries. This will lead to jobs leaving Canada, tax revenues leaving Canada, and other generally negative economic consequences. The government must balance the needs of all stakeholders in order to keep all groups satisfied.

5.1.b Process Industries

The process industries in Canada are primarily concerned with ensuring that a cost-effective strategy is implemented moving forward. This is not to imply that process companies are unconcerned about the safety of their workers, the environment, or the surrounding public. They care a great deal about these groups, but from a business perspective the most relevant issue for a company is the bottom line. These companies exist in order to make money, and to earn long-term financial returns for their shareholders. As a result, the process industries must ensure that their operations and products will stay competitive globally, and do not want to bear the cost of relocating production facilities from Canada to other jurisdictions. At the same time, however, no process companies want to bear the cost and loss of goodwill that come with a major accident. Major accidents can cause property damage, business interruptions, and liability claims due to injury and/or death. In addition, the public will lose faith in the company, and the company can expect to see a decrease in both sales and consumer confidence. Catastrophic chemical accidents often have a disproportionate and long-term impact on the public perception of chemical facility risk (Belke, 2000). As a result, companies in the process industries want to be as safe as possible without losing the ability to compete in the marketplace.

5.1.c General Public

The general public is primarily concerned with their safety, and the safety of their friends and family. If families live close to a process facility, their primary concern is the safety of the facility and those working and living in and around the site. At the same time, however, the general public is also concerned about the cost-efficiency of any strategy moving forward. In the smaller communities

that often house these industrial facilities, a significant percentage of the local population is either directly employed by the facility, or is in a related business that thrives as a result of the industrial activity in the region. As a result, the general public is also concerned about the economic impact of the process industries in Canada, and does not want to lose that source of income.

5.2 Key Player Issues

While the above interests are the interests of general stakeholders, this section highlights the opinions of key players interviewed. These were people currently involved in this issue from the perspective of government, industry and academia. The interviewees were each asked what they believed was the best way to solve this issue moving forward, taking into account their own needs and interests. The responses given fell into three broad categories of solution requirements. The first of these is that further legislation is required to protect the public. The second is that the process industries need more resources in order to effectively plan and implement an integrated PSM program. The third requirement was the need for the enforcement of effective safety auditing in order to ensure adherence to PSM programs. Notable opinions of stakeholders are outlined below.

5.2.a Further Legislation

The recommendations for further legislation represent stakeholder groups from industry, government and academia. The general belief is that Canada will not reach the level of PSM desired without a legislative regime. One technical engineer interviewed felt that the CCPA's Responsible Care®[3] regime is not too overbearing, and this is more than most companies are currently complying with. This is because it is a voluntary program; while self-policing works to a certain extent, not all industry members will take voluntary benchmarks seriously. A representative from the Canadian government believes that a smart and reasonable legislative scheme is required to ensure nationwide commitment to PSM practices. Another technical engineer contacted discussed the need for a legislative scheme to be enforced. He believed that companies need to be given incentives to follow their PSM plans, and punishments for non-compliance, including fines or mandatory inspections for the six-month period following failed compliance audits. Not only would this type of regime protect the public, it would also work to protect corporate assets. In Alberta, 2% of annual GDP is lost due to small accident asset losses. Finally, an academic interviewed stated his belief that the losses incurred during the implementation of such a legislative regime will be far less than the losses occurred during an industrial accident.

5.2.b Increased Resources for Industry

While it is important that regulations are passed into law, it is equally important that industry be given the resources necessary to fully integrate PSM into their business models. Even before companies are educated on the next level of process safety, they need to be educated on the current systems. A technical engineer currently working in industry explained that private actors are unsure whether CEPA 200 applies to their company, and described a current lack of response and feedback from Environment Canada with regard to submitted emergency plans. Industry will need to be given the time and assistance required to understand and implement the new system into their processes. Part of this will involve process companies getting their PSM plan approved by an independent engineer, in addition to regular inspections which will ensure the plan is followed. A government representative reiterated that while this will incur costs for the company, the costs are inconsequential compared to the cost of major industrial accidents.

[3] Responsible Care is a registered trademark of the Canadian Chemical Producers' Association

5.2.c Effective Safety Auditing

A second issue is industry complacency; the onus needs to be on industry to ensure these PSM programs are enforced. One technical engineer supporting this stance stated that while this will cause an initial shock to industry, this focus will be very important in the long run. Another engineer provided some explanation for this, discussing that the responsibility cannot rest solely with auditors to identify problems with a PSM program as it is difficult for an independent auditor to come into a company for the first time and understand everything about its PSM plan. This issue is complicated by the fact that the culture of the company is so important to process safety, and it is very difficult for an auditor to get a sense of the corporate culture without spending more time in the environment. The final issue with regard to effective safety auditing, from discussions with engineers in industry, is the lack of expertise in the government. This will make it difficult for government officials to effectively regulate and enforce a PSM regime. This raises the question whether there should potentially be an industry body with this expertise in control of auditing process safety at industrial facilities.

5.2.d Problem to be Solved

The purpose of this report is to determine the best way for Canada to reduce its exposure to the risk of a major industrial accident. The main players are the government of Canada, the Canadian process industries, and Canada's general public. While each of these stakeholder groups has a general interest in this issue, the interview of key players in Canada has led to a general direction for the solution. Industry needs to be educated and given time to adjust for, and implement, these new programs. Once industry has been educated and PSM has been implemented, compliance to the PSM program must be strictly enforced by independent auditors. Finally, as there is a lack of expertise in the government, a new body may be required to monitor and enforce PSM in Canada. For this scheme to be effective, however, it is clear that there needs to be full commitment from all levels of the organisation – from the board room to the plant floor. Corporations must embrace a culture of PSM, and the benefits of such an integrated PSM plan in the future are expected to far outweigh the costs in the present.

6.0 COST-BENEFIT ANALYSIS

This section of the report aims to provide an overview of the benefits and costs associated with increasing PSM regulation in Canada. These benefits and costs will be examined from the perspectives of industry in general, as well as individual process companies. As these stakeholders will be affected by new regulations, it is important to understand whether they will be left benefitted or essentially unchanged. This section will examine:

a. The process industries' ability to stay competitive and innovative with new regulations
b. Cost to industry of regulation
c. Costs of implementing PSM program at individual companies
d. Long-term economic benefits of adhering to PSM
e. Reduced risk of large scale accidents

While the costs and benefits have been quantified as much as possible, the difficulty of quantifying benefits and costs leads to certain elements of this section being evaluated on a qualitative basis. In addition, there is the need for a relative comparison of the benefits and costs of different types of regulation across jurisdictions. This also proves to be a difficult task, largely due to reporting differences between jurisdictions, and the difficulty of quantifying very long-term benefits. These two elements are examined first.

6.1 Difficulty of Quantifying Costs and Benefits

There are three main difficulties with regard to quantifying benefits and costs. Firstly, many of the costs and benefits resulting from a new PSM system are incurred within normal business operations. As a result, it is difficult to separate the costs and benefits attached to PSM regulation from the rest of the costs and benefits of day-to-day business operations. In addition, different companies currently have different levels of PSM within their organisation. If regulation is introduced, all companies will essentially be at a different 'starting point' in terms of how much they need to invest to bring their operations into compliance with the regulations. This will lead to a large discrepancy in implementation costs between individual companies, and will make the calculation of an aggregate industry cost number almost impossible. Even if companies were all at the same starting point, the individual needs of each facility are often site specific, leading to very different estimations of implementation costs. Finally, many of the costs associated with implementing a new PSM system involve employee time and effort. This is also difficult to quantify, as actions aimed at improving PSM in the company are intertwined with day-to-day activities of employees.

There are three main issues when it comes to comparing the regulatory regimes of different jurisdictions. Primarily, the costs of regulation are difficult to compare across studies of different jurisdictions, as some studies identify only private costs of regulation or de-regulation, while others include social/environmental costs and benefits (Mahdi, Nightingale and Berkhout, 2002). In addition, differences between regimes are difficult to compare as a result of quantifying the costs and benefits of regulation, and the subjective nature of evaluating public policy decisions (Mahdi, Nightingale and Berkhout, 2002). Finally, there are uncertain and time-lagged costs associated with accidents that occur as a result of a less stringent regulatory system. These costs are usually socially or environmentally based, and may not present themselves in the short-term. This makes them very difficult to include in a present day cost-benefit analysis, even when only slightly more care today could have the potential to avoid major costs in the future (Mahdi, Nightingale and Berkhout, 2002).

6.2 Impact of Regulation on Innovation and Competition

Industries have historically shied away from increased regulation, often citing that more regulation hurts an industry's ability to be competitive and to innovate. While the introduction of regulation will surely cause an initial shock, competitive and innovative firms survive through product substitution and entry into new markets (Mahdi, Nightingale and Berkhout, 2002). Firms in all industries constantly face new regulation and must be dynamic and adaptable. The issues to consider include the length of time before the industry recovers, and who benefits from this regulation.

Current academic research on this topic suggests the following conclusions:

1. There is no general agreement of whether regulation inhibits or stimulates innovation in the industry; in many cases regulation seems to be doing both. In some countries, the most successful industries are those that are governed by the highest levels of regulation.[4]
2. New regulation causes a temporary shock to innovation in firms. This has a negative impact on the effective rate of innovation, but the longevity and severity of the shock differs from case to case (Mahdi, Nightingale and Berkhout, 2002).
3. The rate at which regulatory bodies are contacted to identify new chemicals has increased over the past 10 years. While there are several reasons that industries under different regulatory regimes are introducing the same number of new chemicals, the finding certainly undermines the claim that regulation in all circumstances will inhibit innovation (Mahdi, Nightingale and Berkhout, 2002).
4. OSHA anticipates that as PSM becomes widespread throughout American industry, the productivity benefits and other cost-savings resulting from the rule could improve the competitiveness of American businesses (OSHA, 1992).
5. OSHA anticipates that the maximum price increases generated from the implementation of PSM would be less than 0.3 per cent for the majority of affected establishments. Thus, no measurable impact on foreign trade is expected (OSHA, 1992).

At this time, it is unclear how long the initial regulatory shock would last in Canada's process industries. While the net benefits and costs of industry regulation are examined in the following section, one conclusion begins to form following this initial section. That is, current research seems to be inconclusive as to the full effect of regulation on an industry, but increased regulation does not appear to stifle competition or innovation in a meaningful way. Despite a lack of concrete financial information and analysis, at this point it seems unwise to trade the likely social benefits of a more stringent regulatory regime for the private costs that it imposes, given the weak evidence that these costs substantially reduce innovation (Mahdi, Nightingale and Berkhout, 2002).

6.3 Cost of Regulation

The following section analyzes the projected benefits and costs of PSM regulations currently in place in the United States and Canada. The United States case study looks at the OSHA projection of the impacts of its PSM rule. The Canadian case study looks at environmental emergency preparedness within the Canadian Environmental Protection Act (CEPA section 200), and Environment Canada's projections of the benefits and costs of this legislation. The net benefits and costs are examined below.

6.3.a Case Study – OSHA

OSHA has completed a very thorough analysis and estimation of the impact of their PSM rule. The PSM Rule is a standard within Subpart H, Hazardous Materials, which involves the storage, handling,

[4] For example: Pharmaceuticals in the U.K. compared to France, chemicals in Germany, and pulp and paper in Sweden.

and processing of highly hazardous materials (OSHA, 1992). This standard stresses management controls rather than specific engineering guidelines when addressing the danger associated with handling and working near hazardous chemicals. This standard aims to enable facilities to prevent the occurrence and minimise the impacts of accidents at processing facilities. OSHA outlines the benefits of PSM as (OSHA, 1992):

a. The prevention of accidental fatalities, injuries and illnesses, and the avoidance of physical property damage.
b. Enhanced productivity due to fewer process disruptions and accidental shut-downs.
c. Decreased labour turnover as workers perceive a safer work environment.
d. Programmatic plant reviews lead to the more efficient allocation and utilization of space, labour and equipment.
e. An integrated approach to process design, construction, operation and maintenance, with PSM as the central focus of their concern.
f. Increase in product quality

From a qualitative perspective, savings in these areas generated as a result of PSM are expected to offset the direct costs of compliance (OSHA, 1992). As already stated, many of the costs involved in the implementation are due to employee time and effort. Capital costs will be incurred by firms only when process hazard analyses identify the need to redesign processes in order to reduce risks. While this project deals with acute risk, OSHA also anticipates significant improvements in chronic risk scenarios, such as ongoing health and safety issues due to long-term, low level exposure to toxic substances (OSHA, 1992). All of these are the qualitative benefits of OSHA's PSM rule.

In addition to this qualitative analysis, OSHA also estimated the overall costs of the new regime over the next 10 years. They are shown below:

Table: OSHA Estimation of Costs and Savings (in millions)

	Years 1–5	Years 6–10
Direct Costs	888.70	$ 405.80
Cost Savings	719.90	$ 1,440.00
Net (per year)	-168.80	10364.2
Net (Total)	-$ 844.00	$ 5,171.00
Total	$ 4,327.00	

OSHA estimates that US$888.7 million in direct annualised costs would be required to comply with the standard during each of the first five years. In each year, 53 per cent of these costs are focused on process hazard analysis, and 20 per cent of the costs on change management. Estimated costs in the following five years are significantly lower, at US$405.8 million per year. This decline in costs is due to the completion of process hazard analysis.

Cost savings are generated through the improvement of employee productivity and the reduction of property damage, lost production time, and employee turnover (OSHA, 1992). These benefits are derived from achieving full compliance with PSM regulations. These costs are expected to be US$719.9 million in each of the first five years and US$1.44 billion in each of the following five years. This gives net PSM costs of US$168.8 million in the first five years and cost savings of US$1.034 billion in years 6 to 10.

These numbers can be seen as very optimistic, particularly the US$4 billion in cost savings over the second five years. Using a required rate of return of 10 per cent, the Net Present Value (NPV) of this project is over $1.4 billion, making it a very profitable venture. See Exhibit 1 for NPV calculation located in the appendix. If this is truly the case, it is in the best interest of all firms to embrace PSM.

Despite inaccurate cost estimates and the high cost of developing and implementing PSM, most companies have seen comparable or even greater benefits as a result of implementing PSM programs (Bridges, 1994). While the benefits of a PSM program may not save almost US$5 billion in costs over the next ten years, the benefits seem to be equal to the costs, if not more valuable (Bridges, 1994).

6.3.b Case Study – CEPA Environmental Emergency Preparedness

Environment Canada has done a similar analysis of the projected benefits and costs of CEPA section 200. The goal of this regulation is to enhance the protection of the environment and human life and health in Canada by mandating systems to address the prevention, preparation, response and recovery of major process accidents and hazards. The benefits of this regulation focus on decreasing the likelihood of an accident causing environmental damage or health related problems. The cost of compliance is largely related to the time and human resources required to prepare or amend, test and implement an emergency plan. Many elements of PSM and emergency plans are site specific, so it is difficult to quantify average or aggregate cost estimates of compliance (CEPA, 1999).

Environment Canada expected the overall compliance costs for affected facilities to be moderate. One of the reasons for this is that 90 per cent of the operational capacity in the industry is represented by CCPA membership. As already stated, the CCPA has a Responsible Care program, and many of these facilities already have environmental emergency plans in place. In addition, representatives of large facilities in industries such as petroleum, mining, and pulp and paper confirm that their organisations already have emergency plans in place for safety, liability and insurance reasons (CEPA, 1999). One group which may be affected are the small and medium sized companies who use hazardous chemicals at threshold quantities. These sites will have to bear the cost of hiring experts to develop environmental emergency plans, the cost of which will range from minor to significant, depending on the size and complexity of the operation.

The costs of this regulation to the government of Canada are also expected to be minimal. The number of facilities in Canada required to take action under these regulations is expected to be 1,500, or 10 per cent of the 15,000 facilities in the U.S. that are under the Risk Management Planning Regulation. Compliance promotion and enforcement costs are estimated at C$350,000 per annum, which includes salaries and benefits of environmental emergency officers and enforcement officers to inspect and verify compliance with the regulations (CEPA, 1999).

It is difficult to estimate average or aggregate costs for implementing a PSM program, as the requirements can be interpreted differently for each site based on local needs, and each organisation begins from a different point based on its historical commitment to process safety. The different levels of PSM also make it difficult to estimate overall costs of implementation. Some companies take a minimalistic approach, while others go far beyond the required levels. The minimalist companies, while they may survive an OSHA audit, will minimise the benefits of PSM by not embracing it. A company which goes far beyond requirements will incur a greater cost, but will presumably receive greater benefit (Bridges, 1994).

6.4 Benefits of Regulation

This idea leads well into a discussion of the specific benefits of embracing PSM. The CCPS "Business Case for Process Safety" outlines four ways in which a business will benefit from embracing a widespread PSM program: corporate responsibility, business flexibility, risk reduction and sustained value. These benefits are crucial to the success of any business, and they combine to support the profitability, safety performance, quality and environmental responsibility of an organisation (CCPS, 2006)

Corporate Responsibility: Commitment to PSM demonstrates a firm's commitment to its employees, the surrounding communities, and the local environment. This also enhances supplier/customer relationships, allows investors to perceive the business as lower risk, engages all employee levels and increases loyalty, retention and morale. In addition it allows a business to obtain insurance at reduced rates, enhances the confidence of lenders for new capital projects, and builds a reputation for the business as a leader in the community. All of this is a consequence of the perception that the organisation is committed to safety and sustainability (CCPS, 2006).

Business Flexibility: Embracing a strong process safety regime gives the business a strong reputation. As a result of the trust gained from regulators and the local community, a business will be given more autonomy to determine its own direction and strategy. There will be less involvement from community groups and regulatory organisations that do not trust the business to carry-out safe and effective practises. A company's freedom to operate can be severely compromised due to community discontent, regulatory scrutiny, legal complications, and even intervention by a company's own board of directors when key stakeholders sense increased risk.

The reduction of all these factors allows a business to be far more flexible and dynamic and situates an organisation in a better position to deal with new regulation in the future (CCPS, 2006).

Risk Reduction: Embracing a more intensive safety regime at a process facility directly reduces the risk of injury or death. This works to reduce lawsuits that result from injury or death, and also allows a company to retain its well-trained employees. As accidents are reduced, property damage and business interruption costs incurred over a given year are expected to be reduced as well. Finally, the avoidance of a major accident allows a company to maintain its relative position in the market. After a major accident, a company loses market share until its reputation is restored; the more severe the accident, the longer it takes to once again earn a credible reputation (CCPS, 2006).

Sustained Value: The chemical processing and petroleum companies who participated in the CCPS Business Case for Process Safety study experienced cost savings throughout their business. Many experienced up to a 5 per cent increase in worker productivity, and up to a 3 per cent reduction in production costs. Companies also saw their maintenance costs decrease by up to 5 percent, and found they required 1 per cent less capital in their capital budget. Finally, companies realised a reduction in insurance costs of up to 20 per cent. These are all extremely valuable cost savings, and are directly attributed to the implementation of a PSM program (CCPS, 2006).

6.5 High Accident Costs

The high cost of accidents alone should be enough incentive for companies to embrace a PSM oriented culture. This report looks at two aggregate studies – The Marsh study and the Flixborough study – to estimate costs of accidents.[5] The purpose is to show that over-and-above the cost savings generated by PSM programs, the reduced risk of a major accident should be incentive enough to get organisations to incorporate PSM in their culture. Before examining the high costs of accidents, however, it is important to have an overview of reported problems with cost figures for accidents:

Scope of the cost: The majority of cost amounts focus on the costs to the company itself, some only accounting for reconstruction costs while others include estimates for business interruption losses. Most cost statements exclude the cost to other organisations involved in the response to a major accident. The Flixborough study was unable to find one published report that included the costs to the civil emergency services and health authorities (Hirst and Fewtrell, 1998).

[5] These two studies prorate accident costs to 1997 and 2000. For the purposes of this report, the three year timing difference between these two dates is ignored.

Timing: The full extent of associated costs is normally not known until many years after the event. This time lag allows for a thorough review of the incident, and how the company was affected. In addition, some costs such as health continue to be incurred for many years after the event. For example, the belief for the final cost of the Flixborough accident was ten times greater than the initial public estimate.

Replacement Cost: Costs for the reconstruction of plant are primarily based upon the physical cost of equipment parts and thus do not include the cost of ongoing site personnel, contractors and plant redesign. It is further complicated because plants and equipment will have been at different stages of their useful lives, and replacement costs may be more than the value of the asset.

Commercial Sensitivity: Companies may prefer not to acknowledge the full extent of their losses from an accident; such information could depreciate the value of the company's stock. It could also signal to competitors the full extent of the damage done, and create concern throughout the supply chain about the stability of the company and upward pressure on prices.

The Marsh study was limited to hydrocarbon processing facilities. They limited the analysis to accidents where losses of greater than US$10 million were incurred, as many of the larger processing facilities have a property damage insurance deductible in this range. This criterion limited the number of accidents studied to 379, the total property damage of which totalled approximately US$22 billion.[6] These loss amounts include property damage, debris removal, and clean-up costs, but exclude the additional costs of business interruption, employee injuries and fatalities, and liability claims.

The average cost of these accidents is extremely high, at US$58 million, and basically only includes replacement costs. When one factors in business interruption costs, the loss of public goodwill, and liability claims, the number is expected to be significantly higher. The Marsh study concluded that 'most of the lessons learned center around process safety management program issues' (Marsh and McLennan, 1996). These lessons learned indicate the need for a fully integrated PSM program, with a strong safety commitment from both senior management and plant managers. The more technical recommendations of the Marsh study can be found in Exhibit 2 of the study, in the appendix.

The Flixborough study aims to provide information for companies to assist them in determining which loss prevention measures are most effective. The total costs of the top twenty U.K. accidents is estimated at 430 million pounds; when including smaller accidents, the total costs are assumed to be in excess of 500 million pounds.[7] This is between $613 and $713 million in United States currency, at today's exchange rate. The study also analysed fourteen overseas accidents and determined there was potential for even greater losses in these types of accidents. This is because each of the fourteen accidents analysed in this study caused losses greater than any experienced in the U.K. (excluding Flixborough).

The study concluded that there was a lack of reliable data in the public domain on the costs of major industrial accidents. The authors finished with the concept that there needs to be a full scale cost study to determine the true cost of major accidents. In the author's opinion, this sort of research would provide increased incentive for the implementation of management safety systems such as PSM to prevent such accidents in the future (Hirst and Fewtrell, 1998).

Both studies have concluded that there is a lack of reliable information with regard to the costs associated with major accidents. Based on the information available, the costs of this type of

[6] The losses are reported in January 2000 dollars trended using an inflation cost index for petroleum equipment. Based on data available, they attempt to state dollar losses on the basis of cost to repair or replace assets damaged or destroyed.

[7] Figures are in 1996 dollars.

process-based acute accidents appear to be very high. If full cost information was available, it is expected the costs of these accidents would be significantly higher. The findings of both reports show that it is in the best interest of process companies to embrace an integrated PSM program. With more accurate cost data, the incentive to incorporate PSM in order to avoid major accidents is expected to be much higher as well.

In conclusion, the benefits of embracing a PSM program appear to outweigh the costs of its implementation and compliance. While there are difficulties in accessing accurate cost estimates and comparing net benefits across regulatory regimes, the integration of a PSM program appears as a net benefit for a company over the long term. There is no conclusive evidence that increased regulation stifles an industry's ability to compete and innovate. The cost of regulation to both the U.S. and Canada is seen to be made up for in the gains of PSM. While the implementation costs will change based on companies' current integration of PSM and their commitment to it in the future, there are many quantifiable benefits that have been experienced by different process companies after the introduction of a PSM program. Finally, the enormous cost of major accidents is a major liability for any process company, and the integration of a PSM program will mitigate the risk of such an accident. The net benefits of each portion of this analysis combine to give evidence that it is in the best interest of process industry companies to embrace process safety management systems, and to incorporate these philosophies into their corporate culture.

7.0 FACTORS INFLUENCING A PRACTICAL APPROACH FOR CANADA

7.1 Canadian Specific Requirements

It is vital that whatever recommendations are developed work in the Canadian context. There are six categories that were broadly considered:

- the solution is politically viable for the government
- the solution is effective in reducing major accidents
- the solution rewards good players and punishes bad players
- the solution is acceptable to Canadian industry
- the solution does not lead industry to leave the country, and
- the system works with the provincial/federal governmental structure of Canada.

7.1.a Political Viability

The first requirement of political viability to government means two things. First, while the solution is being implemented the recommendation will not face serious political opposition. The second requirement is that the recommended solution should not become politically unsupportable should there be an accident at some point in the future. Naturally, even a good system that is so poorly administered as to allow an obviously preventable accident to occur would become politically indefensible. Assuming that the scheme is carried out effectively, the question is: Would it seem rigorous enough to satisfy the public in the event of a major accident?

From the interviews conducted there were generally two comments. First, the government is open to a variety of solutions on this issue, and second, that public reaction in the aftermath of an accident is hard to predict and is likely to be very fact-specific.

7.1.b Effective in Reducing Major Accidents

As a second requirement the solution must naturally be effective in reducing the risk of damage done by a major accident in Canada. This criterion speaks to the effectiveness of proper PSM as compared to other discrete options such as a simple land-use planning regulation or a mandatory insurance scheme.

The idea that good PSM would improve safety was echoed almost universally in the interviews conducted, although some people placed emphasis on different aspects. For example, one of the interviewees felt that land-use planning was the only important factor and emergency response plans for local fire departments were virtually useless as most fire departments cannot implement a plan even if they want to due to lack of training and equipment. Others felt that the most important role of a process safety plan was the fact that it created a dialogue between all of the affected parties. Just how effective each element of a good PSM is is debatable, but there seems to be wide support for the notion that PSM in general is effective.

7.1.c Industrial Rewards and Punishment

The solution must also be targeted and reward the good players and punish the bad ones. Targeting large process industry companies that already operate in a very safe manner while ignoring a smaller, yet more dangerous one will not lead to a viable long term result. Even if the reward to better industry players is simply to require their competition to meet their standards, by putting all

industry on equal footing the plan should be seen as fair by those in industry.

One of the more common sentiments heard in the interviews is what a good job most companies in Canada are doing already.[8] The CCPA Responsible Care program is an international model and is followed by the vast majority of the chemical industry already. Most industry players seemed to feel that the real problem lay outside their company's control with smaller operators having relaxed safety standards or with municipal governments who allow encroachment upon plant buffer zones over time. A plan that accepts that the Responsible Care program is a reasonable baseline for behaviour needs to take into account that many companies are already implementing Responsible Care and not simply place burdens upon those companies while ignoring those who actually operate below the Responsible Care standard.

7.1.d Accepted by Canadian Industry

A solution that works for Canadian industry is a solution which would not be distasteful to our industry players. Regardless of the merit of the position it was a fairly common refrain from our industry interviews that some kind of complex government legislative scheme combined with government inspectors was unwelcome. Every solution relies to some degree on good faith efforts; a program that is not liked at the industry level will have a more difficult time gaining support than a program that industry is supportive of. While non-industry players such as government and academics felt this factor was less important, the reality is that industry support for a PSM regime is vital because from our interviews the single most important factor seems to be management attitudes. If management feels that safety requirements are simply rubber stamping forms it will be hard to truly implement effective PSM. On the other hand, if management is committed to the highest safety standards, then that attitude will permeate the organisation and lead to meaningful implementation in substance and not simply form.

7.1.e Competitive Industry

With global markets so easily available, outsourcing of chemical production was a common concern. The prospect of industry leaving or stopping investments in Canada was specifically considered. That said, it is important to consider the regulatory framework in the rest of the world. None of the solutions considered are as restrictive as either the European or American regulatory environment. Furthermore, as chemical facilities tend to represent rather large, fixed, capital investments there is a degree of elasticity in what industry will tolerate before it considers changing locations. The consensus on this issue was that regardless of the legislative scheme, industry would not relocate.

7.1.f Canadian Government Structure

The final factor considered was the legal jurisdictional question. If legislation could be passed at the federal level, only one bill and one lobbying effort would be required and it would lead to a single unified system throughout the country. By contrast, if the proposed solution required provincial legislative competence to implement, it would require passing in each province and regional variations could lead to varying requirements throughout the country.

[8] Indeed, the number given by several interviewees was that 90 per cent of the chemical industry is a part of the CCPA.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Recommendation Overview

The recommendation is divided into three parts:

1. That the CCPA lobby the Ontario provincial government to create an industry body ("the objective body") which would audit, verify, and generally conduct inspections for industrial facilities meeting threshold minimums.
2. That the CCPA lobby the federal and provincial governments (at the very least, the federal and Ontario governments) to cement a regulatory code of PSM practices. The provincial regulation should include a statement that any company falling within the thresholds must submit to mandatory membership to the objective body.
3. That the CCPA lobby the federal government to create a body similar to the Chemical Safety and Hazard Investigation Board (CSB) that exists currently in the United States.

These recommendations resolve the key issues at the heart of the problem. If a more government-heavy solution was suggested, the government could not run it effectively as it does not have the expertise to be conducting PSM verifications at this time. The question of enforcing a formal government regime is unanswered. At the very least, bodies such as the CCPA would need to take some sort of role in training at the beginning of the program. Consequently, the CCPA would have to be involved at points throughout the process anyway; it is better for the CCPA to be involved right from the beginning. This way, the CCPA can help quickly build a regime based on expertise rather than political expediency.

Note that all three "parts" to the recommendation could be done on a "stand alone" level. However, the strength of the recommendation comes from the combination of the three elements. Having all the suggestions adopted could ultimately result in an expertise-driven verification and auditing regime backed by a minimally intrusive regulatory structure. The intention is to allow a public-private partnership to progressively develop. The recommendation suggested should allow for an effective public-private partnership to take root and address the issues which brought about this project in the first place. The federal government regulations are intended to be minimally intrusive and will simply state that all companies will have to abide by PSM. The provincial regulations will force companies carrying the threshold level of chemicals to join the objective body. In the end, what should occur is that those with the expertise will be able to effectively share their knowledge and resources with actors who may not have the best understanding of the issue, while the regulations allow for punishment of those who choose to not follow the guidelines.

8.2 Objective Body Development

Process industry companies utilising a given threshold of quantities of hazardous materials should be required by legislation to have membership in the objective body. This objective body would perform tasks similar to what Responsible Care does now: setting benchmarks and guidelines for the chemical industry, continuing its current responsibility for site inspections and ensuring members are maintaining prescribed standards. While this role could be played by any newly formed organisation, the level of experience and knowledge required to manage such an organisation is already contained within the CCPA and its Responsible Care program, so the objective body would heavily be composed of these personnel. The CCPA has been representing Canada's chemical industry since 1962, and this level of industry presence and experience will be required to initiate and manage a national process safety regime. The CCPA/Responsible Care already has a procedural framework

which utilises verifiers, auditors, and PSM specialists to manage membership companies. This provides a competitive advantage over the government or a brand new organisation in terms of start-up time, understanding practical issues of PSM in industry, and developing the expertise and contacts required for initiating this venture.

8.3 Policy Framework

The organisation would be funded through membership dues, and would require the creation and update/review of companies' PSM programs and emergency plans. The organisation would have to involve local emergency response agencies in the plans in order to ensure full preparation in the event of a 'worst-case-scenario' accident. Every time a significant change occurs in a company's process, it would be required to incorporate this into updated PSM and hazard response plans. In addition, the objective body would have the ability to execute on-site inspections at facilities, in order to identify discrepancies between the PSM and emergency plans, and actual processes at the organisation. If the company keeps up to date on process safety, and is careful to acknowledge and address the acute risks faced by its facility, it would be rewarded. If the company's plans are out of date, or if it has been untruthful in the plans outlined to the objective body, the company would be punished.

The current punishment regime is ineffective because for companies which do not meet the benchmarks a fine of $50,000 or $100,000 would be incurred, which is a comparatively small expense for a significant number of companies. As a result, a company's reward and punishment should be based on public exposure and humiliation. This would involve the publication of a 'Best and Worst of Canada's Process Industry', either in its own publication, piggy-backed onto an existing publication, or published online. This would be a very clear communication to the public as to which companies are committed to the safety of their workers, the surrounding public, and the local environment, and which are not. Companies on the negative side of this publication would experience a loss of customer goodwill, compromised industry credibility, and an increase in inspection frequency by the objective body.

8.4 Industrial Site Classification Criteria

8.4.a Hazardous Substances: Classification Lists and Threshold Quantities

Chemicals are used by a wide variety of industry beyond the chemical industry, so it is important that the classification list set out by law requiring mandatory membership in the new objective body does not catch small operations or non-chemical companies. As a basis for threshold quantities and a list of substances, CEPA Section 200 should be used. This list is based on three lists of chemical classification developed by MIACC. Chemical companies which utilise substances from List 1 and List 2 would be required to have membership. List 3 pertains mainly to environmental hazards and is not pertinent for PSM. A description of MIACC Lists 1 and 2 from the CEPA Environmental Registry website is provided below. A full list of chemicals and the threshold quantities is provided in the appendix.

8.4.b MIACC List 1:

MIACC List 1 contains 33 hazardous substances. At the time that the MIACC Lists were developed, these substances were those that were involved in the highest number of accidents in Canada. An accident involving a List 1 substance and quantity could potentially result in a number of on- and off-site fatalities.

8.4.c MIACC List 2:

MIACC List 2 contains 212 hazardous substances. These substances are a combination of MIACC List 1 (at lower thresholds), Extremely Hazardous Substances listed under Section 302 of the EPCRA (SARA Title III) and hazardous substances listed under SEVESO I Directive. Hazardous substances from SARA Title III and SEVESO I were retained if they were listed on the Domestic Substances List (DSL). The threshold quantities in List 2 were based on the quantities set in SARA Title III, SEVESO I and the expert opinion of members of MIACC Working Group 1. The release of these substances at the quantities specified could result in on-site fatalities and off-site injuries.

8.4.d Site Location, Operation Characteristics and Operators

To ensure that site location is taken into account, even with companies which have multiple processes at different locations operating under the same conditions, the objective body should enforce the OSHA standard of a site-by-site basis for PSM verification. This ensures that each facility is operating at the same standard and that each facility takes the local environment into consideration when developing its PSM protocol. As recommended in *8.6 Emergency Preparedness and Communication of Information to the Public* it is important for the public to be educated and informed regarding plant processes and potential acute risks. This interaction between public and industry stakeholders should be part of a company's PSM framework. Therefore, effective incorporation of public input should be monitored by the objective body.

8.5 Control Measures

8.5.a Risk Assessment

The verification and re-verification currently used by the CCPA should remain in-place. Initial verification requires a 150-item questionnaire sent to the company in preparation for necessary documentation. These questions are open-ended and require explanations allowing the new objective body's auditors to gauge PSM knowledge and proper application. Furthermore, the re-verification cycle of three years should remain, but for companies that fail to meet the benchmarks during the verification process, a re-verification time period of one year should be used. Currently a "top-down" method is used by the CCPA, but this should be expanded to a more inclusive method. Rather than testing senior management and site operations separately, these two groups should be simultaneously tested so the differences in interpretation between management and on-site workers can be exposed.

Furthermore, to ensure companies are able to independently verify their own processes, the new objective body should require companies to perform their own audits and testing.

The first stage of this internal company verification process would require a team working in that area of the process to perform an audit and to expose any process safety concerns with solutions.

The second stage is for a team within the same company but from a different process to perform an audit and to expose problems and propose solutions. This second stage provides an opportunity for site operators to share and network intercompany PSM developments, allowing the company's overall PSM policy to develop consistently.

The optional third stage involves the use of private consultants or CCPA external verifiers to independently verify the company's PSM scheme. This can include standards that are beyond CCPA guidelines and ensures the company will pass the final verification stage. Furthermore, it provides a checking mechanism to verify if the first two stages of the risk assessment are actually identifying potential process risks and hazards.

The final stage is the actual verification process, which currently includes an auditing team sent to the site every three years. A report is generated and recommendations are provided, even if the site has met guidelines. If standards are not met, a site inspection should be conducted within three to six months. After this second re-verification if the company has not met the guidelines the aforementioned punishment is incurred.

8.5.b Risk Control

To improve risk control all site operators, middle management, and upper management should be trained in the fundamentals of PSM. Furthermore, they should have knowledge regarding the entire industrial process, rather than a narrow view of the process with which they are involved. The CCPA should advise universities to include in engineering curriculums a course on PSM, so recent graduates entering employment will have a solid grasp of PSM concepts and the importance of proper PSM in industry.

8.6 Emergency Preparedness and Communication of Information to Public

Community preparedness is an important part not only of safe practices for companies, but also for community relations. The community should both be safe and feel safe. Members of the community should feel they understand the risks a plant poses, and how they are to react if an emergency situation arises.

This sort of communication and education should be mandatory within a new PSM framework. By holding information sessions for the community, offering written material (brochures, etc), and hosting education sessions in the local schools, companies can further both their image in the community, and the level of safety in the community.

Transparency is very important, as people tend to protest and "demonise" industry when they feel they do not have adequate information. To avoid this, companies should be as open as possible about the hazards that exist at their plant, and the steps they take to avoid major accidents.

One of the problems with the current emergency response systems in Canada is that in some jurisdictions, despite companies having thorough, effective emergency response plans, emergency responders do not have an understanding of the plans or how to implement them. This situation should be addressed to ensure that if an emergency situation arises, emergency responders will know how best to tackle the problem. Open discussion between plant management and emergency responders, and clear, concise direction as to how to respond to emergencies is vital to a healthy, mutually beneficial relationship between the two groups.

Emergency responders should also be kept up-to-date on any changes to materials or processes within the plant, and how their response plans should be appropriately updated.

Finally, just as students practise fire drills in school, companies and communities should also 'test-run' their emergency alert systems, and even their evacuation plans. If community members feel comfortable with their responsibility when an accident occurs, people can calmly take the proper steps required to keep themselves and their families safe.

Although emergency preparedness and education may seem onerous at first, once it has been implemented in a community keeping it up will simply be a matter of reminding community members of the plan. Also, this will foster better company-community relations as community members will feel more comfortable with the hazards of the plant.

8.7 Siting and Land-Use Planning Controls

The issue of land-use planning was mentioned several times in interviews with different key players. By locating hazardous plants in densely-populated areas, the consequences of major accidents

increase exponentially. However, in the case of an area becoming populated after a plant is built, there is little a company can do.

This issue is a complicated one, and different key players had differing opinions. Because land-use planning is a municipal responsibility, it varies from region to region. However, it would be beneficial for the CCPA and the new objective body to offer resource material to help municipal governments make informed decisions on land-use planning. There would be a more uniform approach to land-use planning if a larger body, with the resources to do all the required research, offered assistance to municipalities.

This education package could address categories of different risks companies pose, associated land uses permitted or recommended around hazardous facilities, and finally buffer zone regulation and enforcement.

Buffer zone regulation and enforcement is a particularly important issue because often when a plant first "moves in" people are cautious and take appropriate steps to reduce risk. However, if after five or ten years a major accident has not occurred and the value of the land in the buffer zone has increased, municipalities can be tempted to develop land that was originally to be untouched, or at least resident-free. The education package mentioned above should specifically emphasise the importance of maintaining buffer regions for the safety of the community and the company owning the plant. It is unfair for a municipal government to reduce the buffer zone around a plant, as the company's safety management plan relies on that area being free of sensitive land uses.

There are certain interviewees who have the opinion, "Accidents will occur regardless, so just keep plants away from people." This approach, however, is not feasible for plants already existing in cities or towns, or for the development of new communities. Instead, municipalities should look at the way land classification and land-use planning can balance safety with realistic community layout.

8.8 Monitoring Sites for Effectiveness

8.8.a Major Accident Prevention Policies

The objective body should adopt some of the policies from the UK Major Accident Prevention Policy (MAPP) framework. First and foremost, process industry companies in the objective body should require the submission of a MAPP document. This outlines the objectives of the aims and principles of PSM that the site operator plans to adopt. Although not required to be specific, it is meant to briefly identify and outline potential major hazards and current systems to reduce risk. The MAPP document should be updated before each re-verification by the objective body's auditing team, so it can be reviewed by this team. Discrepancies between PSM objectives and actual PSM conditions can be identified and improved.

This plan should be expanded to include input from management, such that there is a managerial perspective of the company's aims and principles regarding PSM. This provides two advantages, the first allowing the objective body to immediately identify site operators who have a lack of understanding in PSM or a lack of understanding about the process in general. The second would be to identify companies where management and workers on-site have differing objectives towards the overall PSM policy. Both of these parties should be aligned for a successful PSM plan.

8.8.b Technical System Safety and Management System Safety

Beyond the initial submission of the aforementioned MAPP document, companies would be required to submit technical reports regarding their process system to the objective body. This would allow the objective body to arrange for site inspection teams with expertise in the particular type of

process. It would also allow the objective body to immediately identify process hazards and risks and provide feedback prior to the design and implementation of a PSM framework.

To improve upon management system safety the objective body should recommend that companies promote a culture of PSM awareness. Currently, companies enforce a standard of personal safety in the workplace: identifying risks and hazards which may be dangerous to the operator. It is important for workers to understand the consequences and implications of their own actions on the entire industrial process. To foster this culture, employees should be given proper training in PSM, as well as a general understanding of the entire industrial process and not simply their specific aspect of responsibility.

The overall technical document initially submitted to the objective body should contain the following elements:

1. Process safety information
2. Hazard analysis and risk assessment report
3. Procedure and planning for safe operations for installations
4. Emergency planning and response

8.8.c Site Inspection

Upon review of the initial submission of the technical report by the objective body's member companies, the objective body will submit a document containing feedback and measures which must be implemented to meet guidelines. The company should be given three years to fully implement their successful PSM plan. Following the aforementioned stages in 8.5a Risk Assessment, three years later the objective body will provide verification to ensure PSM principles are being applied. Companies should be categorised into three sections: progressive, stagnant and mismanagement.

Progressive companies should be allowed to continue their current PSM models and innovative developments in their PSM planning should be considered as a new guideline by the objective body. Re-evaluation would occur three years later.

Stagnant companies would be companies in which the majority of guidelines are met but improvement is still possible in some areas. To ensure improvement in these areas these companies should be re-evaluated yearly until a progressive status is reached.

Mismanagement companies would be companies that do not submit a MAPP and technical document to the objective body or have not enforced several of the guidelines. The auditing team would expose several risks and determine the current PSM in place is insufficient. Shutdown of the facility may be required in high-risk situations. These companies should be re-evaluated every six months until a progressive status is reached. If a progressive status is not reached after one year, proper punishment should be incurred.

8.9 Major Accident Reporting System

Currently, the CCPA requires reports of all process-related incidents on a yearly basis. Each incident report includes a brief description of the incident and up to two primary and two secondary causes, from those outlined in the PSM guide. The PSM committee then reviews the incidents and identifies causes to see if further investigation is required.

Depending upon the nature of the incidents that occur, guidance may be provided on how to address recurring primary causes, to reduce the likelihood of similar incidents. Final reports are written to serve as a focus for PSM committee discussion and to prompt internal discussion within firms.

This system of reporting should be continued as it promotes transparency, accountability and critical thinking at firms. By investigating not only incidents within a plant, but also learning about incidents at similar operations, the safety environment at all plants can be improved.

In the United States, the US Chemical Safety and Hazard Investigation Board (CSB) investigates and reports on major industrial accidents. This body then effectively educates others by providing information to the public via its website. A body modelled after the CSB would provide accountability and provide another independent voice on the issue. This is a body that would be funded by government, but have a high level of autonomy, acting as an independent investigator. Its primary mandate would be to investigate and issue reports on accidents and malfunctions that occur. The formation of this body allows the public to have easy access to information with regard to accidents and what is being done about them.

It is recommended that the reporting procedures currently used by the CCPA/Responsible Care be maintained by the objective body. Companies would be responsible for completing incident reports thoroughly and with the intent of critically addressing incidents so that they learn how to prevent them from reoccurring.

In general, long-term memory of incidents that have occurred is important to avoid making the same mistakes over and over, and to gain and preserve a thorough understanding of the risks a process poses. By ensuring companies keep records of the reports, and have the opportunity to learn about causes of incidents at other plants, companies are kept aware and conscious of potential risks.

8.10 Recommendation Advantages

If one accepts that change is needed in the regime to control process industry companies the obvious next question is why the changes recommended in this report ought to be chosen from among other possible solutions. While several alternatives were considered for this report the field was quickly narrowed to three possible alternatives by combining recommendations that worked well together and boosted one another and by eliminating solutions that were obviously untenable by one group of stakeholders or another.

8.11 Alternative Solutions

8.11.a Government Regulation

This option would have seen a U.S. or European-style government body created, charged with setting specific regulations that companies were obliged to meet. To dampen the blow, a series of tax incentives would be paid out to companies that comply with the regulation using fines collected from non-compliant companies as a funding source, in effect setting up an artificial, but level, playing field for both good and bad companies regardless of behaviour. One of the major problems with the current Canadian state of affairs as mentioned earlier in the report is that as companies voluntarily implement rigorous process safety management regimes they are being punished for doing so by higher production costs in the short term as compared to their competitors. In effect, the least safe option can appear to be the cheapest option. By fining companies that do not comply and giving those fines to compliant competition, the true cost of goods on society would be better reflected in the final cost of the product.

The reasons for choosing mandatory self regulation over government regulation are, in the end, mostly philosophical. Naturally, industry would be more opposed to government regulation, no matter how mild, because it represents a change in the status quo and because there is a feeling that once the government starts regulating there will be gradual but inevitable increases in the regulation over time. The deciding factor in our deliberations on this issue was really the question of who is best able to respond to and track the changes of industry and make an effective impact. The American experience with government regulation has been for companies to comply with the

letter of the law and ignore its intention, often resulting in strange consequences. As proper PSM truly requires a certain mindset from management, an industry body as opposed to a government one would be the best way to achieve this. Additionally, it was felt that an industry body would be more responsive to changes in industry and technology in creating its requirements than would a government agency.

8.11.b Industrial Mandatory Insurance

This concept makes it a criminal offense to operate a process plant without adequate insurance. Adequate in this context is defined as liability insurance to cover all damage caused by a worst-case scenario acute hazard.

The legislation would be passed as a federal criminal law provision giving jail time to any non-complying CEO. The definitive test for whether a criminal law power is appropriate was articulated by the Supreme Court of Canada in the *Margarine Reference* and is a prohibition with penal consequences and a legitimate public purpose such as peace, order, security, health, morality and the environment. This clearly falls into security, health and the environment so it has a good chance of withstanding constitutional attack.

Based on interviews it appears that most facilities in Canada already carry this type of insurance and so for most industry players there would be no impact. Furthermore, the interviews reveal that there is adequate competition in the insurance industry to ensure that there would be healthy competition to offer the lowest rates to companies for these policies.

This plan does four things. Firstly, it creates incentives for companies to implement the best safety practices available and puts the costs of not doing so on their shoulders. Secondly, it creates incentives for companies to participate actively in land-use planning practices. A rural facility will have lower rates than a company in a metropolitan area, all else being equal, because less damage is possible in the former case. If a municipality wants to circumvent land-use planning provisions and develop closer to a plant it would result in a direct and immediate cost to the plant by increased premiums and thus the plant will have a direct financial motive to lobby for proper land uses. Thirdly, the facilities that choose to operate with poor safety standards in the heart of urban centres will be put out of business by prohibitively expensive premiums. This is an organic as opposed to regulatory way for a business to end as the utility of the operation exceeds its costs; this plan reveals the full costs of operating a facility and places them on the operator, not society. Finally, should a major accident occur, the probability is that it would occur at an uninsured facility and thus public anger could be vented by the criminal trial of the CEO as opposed to being turned on industry with restrictive and damaging legislation.

Most probably the insurance industry would not develop its own recommendations, rather it would verify the risk analysis from facilities and then discount their rates based on factors such as membership with organisations like the CCPA and participation in programs like Responsible Care. All desirable practices would be incentivised and all bad practices would be punished. Finally, in this case, blame for accidents would be placed where it belongs, on the management of companies operating in a reckless manner, not politicians.

The mandatory insurance plan also raised several important questions which, because they are unanswered, ruled out the plan. The idea behind it is to attach a direct, immediate cost to a company's safety practices. This is based on the notion that it is possible to quantify things like the probability of an accident, the change in this probability that PSM brings about and the dollar value of the damage that could be caused by a worst-case scenario accident. Even if all of this was possible, and it is dubious whether or not it is, the safety improvements brought about by this plan

would be less direct. There are only two scenarios where safety would actually improve under this plan. The first is if a plant implemented PSM in order to reap the insurance discount its provider offered for doing so. The second would come from high risk facilities located in high risk areas being forced to relocate or driven out of business by the high premiums required to cover a worst-case scenario accident in the heart of a city. This is a much harsher result for facilities located in cities than the other plans. On the other hand, this plan does something the others do not – it encourages facilities to be proactive in fighting off encroachment.

While an industry or government body may attend a town planning board meeting to argue against a development close to a site, its stake in the outcome is much higher if a company is going to see its premiums jump overnight as each new house or office building goes in around it. Thus, it would then have a real motive to push hard against encroachment. In the end, however, the difficulty in quantifying risk and the more indirect harm reductions this plan would bring about, made mandatory self regulation more appealing in our view.

8.11.c Status Quo

The final alternative to the recommendations suggested in this report is preservation of the status quo. The CCPA and its Responsible Care division would continue acting as a voluntary industry association, CEPA 200 would continue being the official regulatory standard, and industry would continue doing business in the same manner as before. There are two questions that need to be asked:

1. Would continuing the status quo mean that industry would be safer than if the plan suggested in this report was implemented?
2. Would continuing the status quo prove to be enough to prevent onerous legislation from being passed in the event of a major accident?

If PSM practices are still not being applied at a significant number of industry facilities, then the answer to question 1 would be no. While a high proportion of the chemical industry is a part of the CCPA and the CCPA works closely with other industries, there are still sites in Canada where knowledge of PSM is limited, for various reasons. As can be seen from the earlier sections, many in industry feel that the current regime leads to a "checklist" system rather than actual constant monitoring and improving that is key for PSM. If a body does not exist that can educate, monitor and verify all facilities exceeding threshold quantities, it will be impossible to know how well PSM is being implemented across the nation. The chances that continuing with the status quo improves safety are minimal.

Putting aside the opinions of key players for a moment, it should be asked what everyone is willing to risk in maintaining the "hands-off" policy that exists at the moment. As has been seen from interviews and other research, most of the process industry already adheres to guidelines set out by the CCPA. Under the regime that has been proposed in this report, these industry players would have little to lose; they would be performing to largely the same standard they are now. If a major accident was to occur, the probability of some sort of legislation and regulation being passed is significant. The new law affecting industry could be extremely onerous depending on just how much public anger there is. The continuation of the status quo is not advisable for industry because it does not matter how strong one's own company is in safety; it only takes a single "bad company" to have a major accident which ushers in new legislation that is extremely costly to industry as a whole.

The same analogy can be applied to the government. If a major accident occurs, what would happen to those who hold public office and those who work in government ministries responsible for this area of regulation? The answer is unclear, but in the wake of a serious accident both those holding public office and those who are bureaucrats are at risk of losing their jobs and being

publically shamed even if they had little role in creating the situation that allowed such an event to happen. If the actors held responsible by the public are to keep their positions, they likely would have to create policy that they may not necessarily believe in, but feel compelled to adopt due to the public sentiment. Likewise, any new political power that takes over in the aftermath of a serious accident would likely try to "right the wrongs" of its predecessor by passing this onerous legislation. The status quo puts government actors at risk once a major accident occurs; staking everything on the belief that accidents will not occur is foolhardy.

Some may not feel a change in the status quo is needed due to Canada's record of having exceedingly few major accidents. However, the lack of accidents in the past may be due to good fortune rather than policy (perhaps lack of policy would be a better descriptor), and as seen with Sunrise Propane, Canada is not immune to these sorts of events. The process industries deal with hazardous materials on a daily basis and it is only a matter of time before a facility accident occurs and causes serious harm to a community. In the end, the proposal of a government mandated industry body is the solution that can best improve the regime of major accident hazard regulation in Canada as well as pre-empt any poor policy decisions from being made.

8.12 New System Implementation

The CCPA would take the role of first mover in implementation of this new system. As mentioned above, the CCPA would lobby for creation of an industry body ("the objective body"). This would be a new industry body, but the personnel the body would need would necessarily involve those with a close relationship to the CCPA as this is where the expertise lies. Thus the role of the CCPA in creating this new body is significant; the creation of this expert objective body is the most important thrust of the recommendations and it was felt the CCPA is the group best equipped with personnel and technical resources. This would allow for the expertise that already exists to be used from the beginning of the recommendation.

On the recommendations of some stakeholders, it was suggested that regulation be added to a current piece of legislation stating that PSM is a requirement for the operation of industrial plants with the potential for major accidents to address the regulatory side of the project. It was generally suggested regulation would be much easier to pass than legislation, as legislation requires several house readings, lengthy committee study, and a vote.

The Canadian Environmental Protection Act is the best option to explore. A regulation could be added that gives jurisdiction on the issue because of the serious consequences industrial accidents can have on the environment. Given that section 200 of CEPA is already in existence, it could be modified to include stronger references to PSM/risk management and more robust enforcement mechanisms. The opposition to CEPA 200 currently from industry is its increase in senseless 'paper-pushing.' If better oversight provisions were provided for, this could solve the problem.

An addition to the Ontario Environmental Protection Act (the Environmental Enforcement Statute Law Amendment Act, 2005) was also proposed. If a regulation like CEPA 200 with modifications as mentioned above in the federal section were to pass, a joint federal-provincial partnership would develop encouraging adoption of similar measures at the provincial levels. A sample text of a regulation is included in the appendices to this report.

The lobbying aspect would be most economically carried out by lobbying the federal government and the province of Ontario. The risk of process industries fleeing Ontario is low if Ontario acts as a first mover among the provinces. Successfully lobbying these two actors would exponentially increase the chances of success of the project's goals; the policy school strongly believes that the rest of the country would follow Ontario's regulatory framework with regard to major industrial

issues. Further, given that the Sunrise Propane incident is relatively fresh in the minds of many and that safety issues have been in the press frequently on issues from food to toys, the lobbying effort should be easier as a mood of complacency has not yet set in. The lobbying of the federal government here serves to formally codify a set of minimum standards throughout the country. Provincial support is needed so that industry players that meet the outlined thresholds will actually be compelled to join the new objective body.

Similarly, the federal government alone will also need to be lobbied on the issue to create a new watchdog body similar to the CSB. This may be a more difficult lobbying effort as it involves asking for the creation of a new and independent but government body. Nevertheless, the prospects of creating this body are reasonable if the CCPA is not lobbying for an actual governmental inspection and punishment regime for major industrial accident hazards. Government can be reluctant to create more administration (unless, of course, they see an easy way to make political gains) which is why this recommendation is to make the regulations as minimally intrusive as possible. The best way to go about this goal would be to lobby both the Cabinet and the shadow Cabinet. As Canada is in a minority government situation, and may be for some time, multi-partisan support may be critical to securing this particular initiative. Once lobbying secures the creation of such a body, the CCPA should use its expertise to assist with the determination of what the body will look like, its powers, etc.

This implementation plan provides a scheme for the CCPA to use in making these recommendations a reality. Of course, there are other methods available but these suggestions are the most economical while at the same time having a high level of efficacy.

8.13 Stakeholder Interest in Recommendation

It is critical for the recommendation to be adopted by the key stakeholders, namely the government, the general public, the process industries, and the CCPA. Ensuring acceptance was based on four main areas in terms of the proposed solution:

1. Solution politically viable
2. Solution will be effective in reducing major accidents
3. Solution is acceptable to majority of industry; punishes companies with poor performance
4. Industry has ability to remain competitive and flexible

Political viability pertains mainly to the government accepting the idea of an objective body to regulate the industry and providing power to this body. The main drawback is the fear of “empire building” and the formation of bureaucratic organisations, which are unresponsive to both government and industry.

The proposed solution is highly politically viable as it shifts the responsibility for PSM to a single organisation, creating consistent PSM requirements in Canada. The solution is also very low cost to the government, as membership dues are paid directly to the objective body by industry to cover the costs of the program. Minimal supervision is required by the government, except in the form of a supervisory board created to review industrial accidents and recommend methods for objective body sustainability. Furthermore, this plan reduces the probability of a small industrial plant having an accident as it raises the standards to a high, previously voluntary, level. This will lead to public support, giving the public a positive impression of the government for passing the legislation.

As mentioned in Section 3 of the document, referring to the current PSM standards, a good PSM plan in Canada involves both regulatory and voluntary aspects. Previously, CCPA requirements which are used as a framework and extended base for industrial feedback to form the new objective body were voluntary requirements which exceeded regulation in Canada. By imposing these voluntary requirements as regulation, all companies in Canada will be operating at a high standard of

PSM. The benchmarks provided by the CCPA are also quite flexible based on the industrial process, so feedback can be tailored to individual companies. This creates robust PSM plans for each qualifying industrial site in Canada, reducing the overall risk of the process. For this reason, it is expected that the public will accept and support this recommendation.

Applying CCPA voluntary requirements will cost each affected company a significant amount of money, which is an obstacle to overcome in terms of industrial support. The main advantage is that major chemical companies in Canada are already CCPA members and have developed PSM frameworks with the CCPA. Small companies, which may not have a fully developed PSM plan, therefore have an apparent (though likely short-term) advantage over large companies as they can cut costs on PSM, as can those in other sectors. By introducing this recommendation the competition issue would be largely resolved, as the costs of process safety would be borne by all covered facilities.

The main area of concern is acceptance of the recommendation by the CCPA. After implementation, the Responsible Care division will most likely be obsolete as far as PSM is concerned, as benchmarks would evolve from the objective body. Furthermore, any objective body would need to adopt and apply the PSM frameworks and networks developed by Responsible Care. This may lead to privacy issues or issues where CCPA employees, verifiers, or consultants are unimpressed with the proposed change and genuine support is lacking (communication and change-management problems). The advantage of this is that previous CCPA employees would be needed to build on the framework in the new objective body and act as verifiers, inspectors, etc. Essentially their previous role would remain the same. Furthermore, the CCPA itself would still be able to continue as a lobby group and may even be able to bring concerns from clients to the new objective body. Due to the similarity between the CCPA Responsible Care and the new objective body, the proposed solution has a high chance of support from CCPA members.

8.14 Costs of Implementation

This section of the report looks at the costs associated with creating a regulatory organization in Canada, in order to determine whether the costs are prohibitively expensive.

8.14.a MIACC Members

The first step of this analysis involves the estimation of the number of companies which will become a part of this group in the future. A good way to estimate this is to examine which companies were part of MIACC, which was a similar initiative. To get an estimate of involved companies, the membership levels of top industry associations involved in MIACC are identified. Some of the major industry players involved in MIACC, as well as their current number of corporate members, are shown below.

Table: MIACC Members

Acronym	Explanation	Number of Members
CAPP	Canadian Association of Petroleum Producers	130 member companies
CCPA	Canadian Chemical Producers' Association	70 member companies
CEPA	Canadian Energy Pipeline Association	11 members
CGA	Canadian Gas Association	200[9] member companies
FPAC[10]	Forest Products Association of Canada	20 member companies
MAC	Mining Association of C anada	30 members
PGAC	Propane Gas Association of Canada	115[11] members
	Total:	**576**

Based on the membership levels of associations representing process industry companies, there would be 576 potential new members for this auditing body. In the pursuit of conservative assumptions, however, it was assumed that only 50 per cent of these companies become members. This assumption results from some duplication in membership by the same companies across different associations, as well as to account for the fact that not all companies will become members unless membership is compulsory. This leaves an estimate of the number of member companies at 288.

8.14.b Comparison with the CSB

In estimating the costs associated with setting up an auditing body in Canada, it is useful to look at the structure of a similar organisation in the U.S., the CSB.

The CSB is responsible for investigating industrial chemical accidents. The CSB looks into all aspects of industrial accidents, from physical causes to shortcomings in management controls and an overall safety culture. The board does not issue citations or fines, but makes recommendations to companies, industry organisations, labour groups, and regulatory agencies. CSB board members are appointed by the president, and are confirmed by the Senate. In September of 2007, there were three appointed board members and a professional staff of 35.

The costs of running the CSB between 2005 and 2007 are shown in the figure below.

Table: CSB Budgetary Outlays

Fiscal Year	Budgetary Outlay	Change
2007	$8,804,000	-0.5%
2006	$8,850,000	2.0%
2005	$8,680,000	NA

The annual costs of operating the CSB are around $8.8 million. Industry in the US is much more highly concentrated and widespread than it is in Canada; the resultant expectation is that an organisation in Canada should cost much less than the equivalent organisation in the US. On a year-by-year basis, the costs do not deviate far from the average. It can be assumed that the costs associated with running a similar organization in Canada will not increase by large amounts year-on-year.

8.14.c Cost of New Organisation

This requires estimating the number of people able to accomplish a significant amount with all of their time dedicated to receiving reports and going to inspect facilities. Note that this section costs the organisation as if it were one large national body to get a sense of how much the body would cost for Canada as a whole.

It is the belief that 15 qualified process safety auditors would be enough manpower to make significant advances in the field of PSM. They would be technical engineers whose whole job description would involve analyzing a company's PSM system and hazard plan, and then going to facilities to audit the processes. These auditors would be spread out throughout Canada, with more attention being given to industrial provinces such as Alberta, relative to provinces such as New Brunswick.

In order to estimate the cost of these engineers, it is necessary to examine the average industry pay scales for process engineers. These figures are based on U.S. average salaries, but have been

[9] Unclear whether these are all involved in gas production.

[10] In the MIACC days, this association was CPPA, the Canadian Pulp and Paper Association. In its new form, some companies may not need these type of audits, but it is necessary to include them as there are many pulp and paper producers who will.

[11] These are members classified as 'producers'

converted to Canadian dollars. While these auditors would be working in Canada rather than the United States, North America has a very efficient labour market. If qualified process engineers are undervalued in Canada and overvalued in the U.S., skilled workers will begin taking the higher paying jobs in the U.S. As supply increased in the U.S. and decreased in Canada, average worker compensation would balance out across the two countries. As a result, the average salary from below will be used in the cost estimation for 15 process safety engineers.

Table: Process Engineer Salary Scale (Salary.com, 2009)

Process Engineering Level	Base Salary (Average)	Bonuses/Benefits[12] (Average)	Total (Average)
Level 1	$73,501	$31,781	$105,282
Level 2	$84,308	$36,495	$120,803
Level 3	$99,397	$42,665	$142,062
Level 4	$124,589	$60,975	$185,564
Average:	**$95,449**	**$42,979**	**$138,428**

The cost of these engineers will be $2,076,416 annually. Over and above that, a business incurs costs for items such as overhead and administration. These costs include ongoing costs of the business, such as rent, depreciation, insurance, interest, or taxes. Assuming a 35 per cent charge for these additional costs, the total overhead and administration will be $726,745. Finally, although this is not a large operation, a number of managers will be required to oversee the organization, and determine strategic directions moving forward. Assuming a 10 per cent managerial charge, the total cost of these managers will be $207,641.

The total estimated cost of this organisation is $3,010,803 per year. Combining this with the assumption above, an estimate of the average annual cost, per company, of supporting this organisation is $10,450. This is a very feasible cost for an industrial process company to bear on an annual basis. Even in a worst-case scenario, where costs are twice as high as expected, each company would be required to pay only $20,900. In addition, this cost structure is based on the conservative estimate of only 288 member companies. As more companies become members, individual membership costs will be reduced. In comparison with the costs associated with even one major accident, this membership fee is seen as a relatively small preventative cost.

While it does cost more than the current system, and will have the most effect on small-to-medium sized operations, this can be seen as the cost of operating safely within society. If industry is unwilling to bear the financial costs associated with safety, the public should not have to bear the social costs associated with a major industrial accident in their community. The costs associated with creating this type of body are not prohibitive to the recommendation.

8.15 Concluding Remarks

Meeting the needs of all the key players in the issue of major accident control in Canada is no easy task, and finding a feasible solution which increases safety is very complicated. However, the recommendations proposed in this report offer a solution which, although not perfect, improves upon the current system in Canada in what is believed to be the most realistic way.

The proposal addresses the concern of industry players of safety becoming too bureaucratic. This concern is addressed by implementing a non-governmental body to lay out safety guidelines. This body will be able to efficiently make changes to policy if necessary, and will be able to address unique situations individually. Due to the nature of the organisation, the members of the organisation are very important to its functioning and therefore active members can have significant influence on the practises of the group.

Research showed some policy makers were of the opinion industry should regulate itself, and take the broad policies of government and implement them in the most effective way. As mentioned, this non-governmental group does leave power in the hands of industry and the government is not left "baby-sitting" the issue.

By ensuring a government-affiliated board investigates incidents and the actions of the non-governmental body, the non-governmental body is kept "in-check" and not given free reign over safety in industry. This will ensure the body does not become bloated and inefficient, and monitors such things as effective policies and effective fund allocation.

The implementation of this new safety board should not impose significant cost on firms already behaving responsibly, but instead should instigate change in those which are not taking safety seriously enough. Most importantly, the existence of this board will make industry in Canada safer, and although industry has an inherent risk, that risk can be minimised.

Again, this issue is anything but simple. However, the proposed solution meets the needs of all parties involved and meets the criteria set out in the project scope. The implementation of the non-government body and the governmental investigative committee could significantly, and positively, impact industry in Canada.

8. 16 Primary Client Contact:

Mr. Graham Creedy, Consultant and Senior Manager, Responsible Care®, CCPA

8.17 List of People Interviewed

Professor Kevin Banks (Professor, Faculty of Law Queen's University)

- Prior to teaching he worked for many years in the Federal Public Service holding such positions as Director General Labour Policy and Information.

Professor Phil Byer (Environmental Engineering, University of Toronto)

- Professor Byer specialises in environmental engineering and also acts as a CCPA non-industry verifier.

Mr. Marcel Emond (Industry Verifier, CCPA)

- Marcel Emond is currently a CCPA industry verifier who previously was in charge of a large petrochemical company in Quebec.

Mr. David Guss (Engineer, Nexen Oil and Gas)

- Currently involved with Nexen's oil and gas division, previously he worked for Nexen's chemical division.

Mr. Asit Hazra (Acting Director, Prevention and Recovery: Environment Canada)

- Mr. Hazra is an authority on Canadian environmental regulations while also being knowledgeable about the political process with regard to making new regulations.

Mr. Brian Kelly (Specialist in Process Safety Management)

- Mr. Kelly is a specialist in PSM, currently working in Alberta as a consultant for the process industries. Previously, he worked for Syncrude.

Mr. Peter Neumann (Retired)

- Peter Neumann recently retired from being Senior VP National Risk Director at AON Reed Stenhouse, a major risk management, insurance, and human capital consulting firm.

Professor Doug McCutcheon (Professor and Director, Engineering Safety and Risk Management, University of Alberta)

Professor Tanya Monestier (Professor, Faculty of Law Queen's University)

- Prior to teaching, Professor Monestier practiced in the area of products liability litigation. Her research areas include commercial law and class actions.

Professor Vic Pakalnis (Professor, School of Policy Studies Queen's University)

- Vic Pakalnis specialises in mining engineering and has been on secondment to the Queen's School of Policy Studies from the Ontario Ministry of Labour.

Mr. Gerry Phillips (Engineering Consultant, Alberta)

- Gerry Phillips is an engineer who is a specialist in safety management. He works in Alberta as a consultant for industry. Previously, he worked for Nova Chemicals.

Mr. John Shrives (Chair of CSChE Process Safety Management Committee, and Manager, Prevention and Environmental Emergencies Branch, Environment Canada)

Ms. Della Wong (Engineer, Shell Canada)

- Della Wong is an engineer who is a specialist in safety management and holds a great deal of experience in oil, chemical, and insurance fields.

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10.0 APPENDIX

10.1 Example Regulation

A sample of the regulation could look like this:

"Whereas the Cabinet and Ministry of *the Environment* recognise that the issues of the *environment are greatly affected by the potential for major industrial accidents*, the following regulation is made:

Currently, accepted world standards for a robust PSM plan look like this:

< elements of strong PSM plan would be described here >

Any operator which is using any of the following chemicals in quantities of more than < quantities believed by best practices to be dangerous > will be required from < date the regulation to come into force > to maintain an up to date PSM plan:

< list of chemicals would go here >

The Ministry of the Environment, in conjunction with the < Engineering Society >, the Canadian Chemical Producers' Association, < the new objective body > and any other group or individual approved by the aforementioned bodies shall be responsible for inspection and enforcement of the PSM plans and shall have the power to levy punishments and rewards depending on facility management's adherence.

Subject to the discretion of what the inspecting authorities reasonably believe to be appropriate, a facility deemed to have an insufficient PSM shall be subject to any of the following or a combination thereof:

1. public investigation through the < body like the CSB >
2. references in engineering publications
3. closure until practices are brought up to an acceptable standard
4. automatic exposure to treble damages in the event of a lawsuit regarding an accident
5. automatic exposure to Bill C-45 criminal prosecution in the event of an accident."

10.2 Exhibit 1: Net Present Value Calculation

Cash Flows: The chart below calculates the net value created or lost in each of the first 10 years of implementing a PSM program. These increases and decreases of value are – for simplicity – assumed to be cash flows in the next calculation.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Direct Costs	$ 888.70	$ 888.70	$ 888.70	$ 888.70	$ 888.70	$ 405.80	$ 405.80	$ 405.80	$ 405.80	$ 405.80
Cost Savings	$ 719.90	$ 719.00	$ 719.90	$ 719.90	$ 719.90	$ 1,440.00	$ 1,440.00	$ 1,440.00	$ 1,440.00	$ 1,440.00
Net	-$ 168.8	-$ 168.8	-$ 168.8	-$ 168.8	-$ 168.8	$ 1,034.20	$ 1,034.20	$ 1,034.20	$ 1,034.20	$ 1,034.20
Total:	**$ 4,327.00**									

Net Present Value: The chart below discounts the expected cash flows from PSM implementation at an estimated rate of 10 per cent per year. The cash flows are discounted to account for the time value of money. The concept is that $1 now is more valuable than $1 in the future, because the $1 today can be

invested to earn a return. By calculating the net value of all expected project cash flows in the present, managers can see whether the project will earn more than investing the money in risk-free market instruments. A NPV of $1794.4 million over 10 years is a very profitable project.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
FV	-$ 168.8	-$ 168.8	-$ 168.8	-$ 168.8	-$ 168.8	$ 1,034.20	$ 1,034.20	$ 1,034.20	$ 1,034.20	$ 1,034.20
Dicount	1.1	1.21	1.331	1.4641	1.61051	1.771561	1.948717	2.143589	2.357948	2.593742
PV	-$ 153.50	-$ 139.50	-$ 126.80	-$ 155.30	-$ 104.80	$ 583.80	$ 530.70	$ 482.50	$ 438.60	$ 398.70
NVP	**$ 1,794.4**									

10.3 Exhibit 2: Marsh Study Recommendations

a. Conduct process hazard analyses of all process units, both old and new;
b. Consider facility siting issues for both inside and outside the boundaries of the plant;
c. Institute a rigorous change management program, and properly train all employees on changes in operating procedures;
d. Provide regular training for all employees, including standardized re-certification training for all operators;
e. Institute a strong mechanical integrity program that includes equipment inspection, piping inspection, material verification, corrosion under insulation inspection, vibration analysis and metal thickness verification;
f. Enforce a formal energy isolation program such as lockout/tagout;
g. Provide a well-trained emergency response organization that can include employees and/or mutual aid agreements;
h. Develop an emergency plan to deal with power outages, raw material supply curtailment and natural hazards such as earthquakes, hurricanes and floods;
i. Ensure that the formal incident investigation process includes near-misses and is a part of any process safety management regime.